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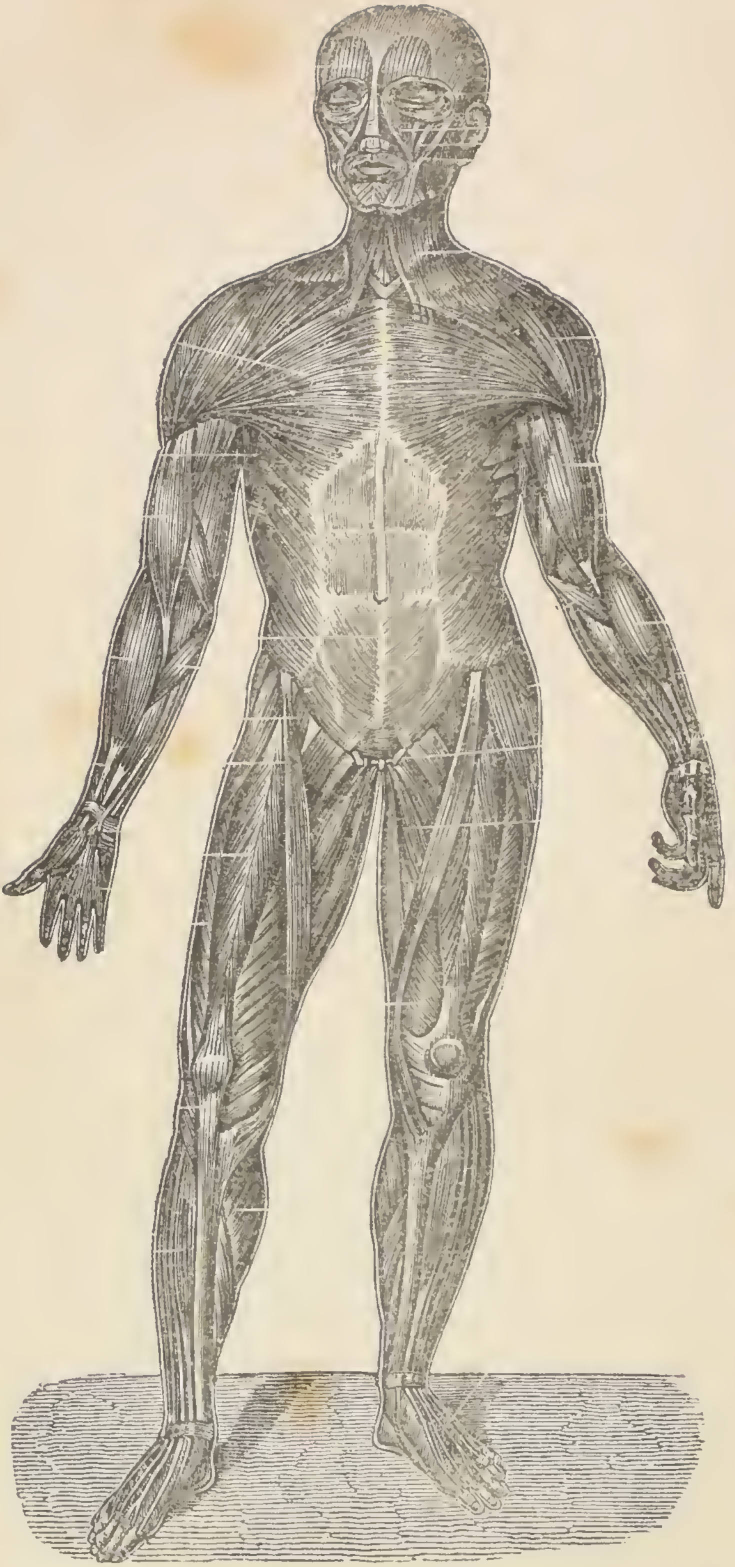

'I AM FEARFULLY AND WONDERFULLY MADE.'—*Ps.* cxxxix.

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ANATOMY

AND

PHYSIOLOGY:

DESIGNED

FOR SCHOOLS AND FAMILIES.

By CALVIN CUTTER, M. D.

Second Edition,

WITH

TWO HUNDRED ENGRAVINGS.

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PREFACE.

AGESILAUS, king of Sparta, when asked what things boys should learn, replied, 'those which they will *practise* when they become men.' As health requires the observance of the laws inherent to the different organs of the human system, so not only boys, but girls, should acquire a knowledge of the laws of their organization. If sound morality depend upon the inculcation of correct principles in youth, equally so does a sound physical system depend on a correct physical education during the same period of life. If the teacher and parents who are deficient in moral feelings and sentiments, are unfit to communicate to children and youth, those high moral principles demanded by the nature of man, so are they equally incompetent directors of the physical training of the youthful system, if ignorant of the organic laws and the physiological conditions upon which health and disease depend.

Hence, the study of the structure of the human system, and the laws of the different organs, are subjects of interest to all,—the young and the old, the learned and the unlearned, the rich and the poor. Every scholar, and particularly every young miss, after acquiring a knowledge of the primary branches,—as spelling, reading, writing, and arithmetic,—should learn the structure of the human system, and the conditions upon which health and disease depend, as this knowledge will be required in *practice* in after life.

'It is somewhat unaccountable,' says Dr. Dick, 'and not a little inconsistent, that while we direct the young to look abroad over the surface of the earth, and survey its mountains, rivers, seas, and continents, and guide their views to the regions of the firmament, where they may contemplate the moons of Jupiter, the rings of Saturn, and thousands of luminaries placed at immeasurable distances, * * that we should never teach them *to look into themselves;* to consider their own corporeal structures, the numerous parts of which they are composed, the admirable functions they perform, the wisdom and goodness displayed in their mechanism, and the lessons of practical instruction which may be derived from such contemplations.'

Again he says, 'one great practical end which should always be kept in view in the study of physiology, is the invigoration and improvement of the corporeal powers and functions, the preservation of health, and the prevention of disease.

The design of the following pages, is to diffuse in the community, especially among the youth, a knowledge of Human Anatomy, Physiology, and the Laws of Health.

To make the work clear and practical, the following method has been adopted.

1st. The structure of the different organs of the system has been described in a clear and concise manner. To render this description more intelligible, two hundred and two engravings have been introduced, to show the situation of the various organs. Hence, the work may be regarded as an elementary treatise on anatomy.

2d. The functions or uses of the several parts have been briefly and plainly detailed; making a primary treatise on human physiology.

3d. To make a knowledge of the structure and functions of the different organs *practical*, the laws of the several parts, and the conditions on which health and disease depend, have been clearly and succinctly explained. Hence, it may be called a treatise on the principle of Hygiene, or health.

To render this department more complete, an Appendix has been added, in which the appropriate treatment of Burns, Wounds, dangerous Hemorrhage from divided arteries, the management of Persons apparently Drowned, and of Sick-Rooms, and the antidotes for Poisons, have been detailed, that persons may know what *should be done*, and what *should not be done*, until a surgeon or physician can be called.

In attempting to effect this, in a brief elementary treatise designed for schools and families, it has not been deemed best to use vulgar phrases for the purpose of being understood. The appropriate scientific term should be applied to each organ. The definition or meaning of these terms should be learned and used, not only in school recitations, but in common conversation. No more effort is required to learn the meaning of a *proper*, than an improper term. For example: a child will pronounce the word as readily, and obtain as correct an idea, if you say *lungs*, as if you used the word *lights*. A little effort on the part of teachers and parents would diminish the number of vulgar terms and phrases, and consequently, improve the language of our country. To obviate all objections to the use of proper scientific terms, a Glossary has been appended to the work.

The questions inserted at the bottom of each page are designed for *young* scholars. It will be for the interest of more advanced pupils to read the text carefully, and critically study the illustrating engravings, without reference to the questions.

The author makes no pretensions to new discoveries in physiological science. In preparing the anatomical department, the able treatises of Wilson and Cruveilhier have been freely consulted. In the physiological part, the splendid works of Carpenter and Dunglison have been perused. Many valuable hints have been obtained from the meritorious works upon Popular Anatomy and Physiology, of Combe, Lee, Smith, Rivers, and others.

To the examination of an intelligent public, the work is respectfully committed by

THE AUTHOR.

TO TEACHERS AND PARENTS.

In the arrangement of the second edition, the Physiology has been separated from the Hygiene, or the conditions on which health and disease depend. Thus we have made three distinct divisions — 1st, Anatomy; 2d, Physiology; 3d, Practical Suggestions — to which may be added a 4th, The Treatment of Accidental Injuries, in an Appendix.

To teachers we would suggest, that it may be found most profitable for those pupils whose term of study is limited, to read carefully the *Anatomical* descriptions; but the *Physiology* and *Practical Suggestions* should be attentively studied.

To parents and others we would say, that about two thirds of the present work is devoted to a concise and intelligible description of the uses of the important organs of the human body, and to show how such information may be usefully applied both to the preservation of health and the improvement of physical education. To this has been added directions for the treatment of those accidents which daily occur in the community, making it a treatise proper and profitable for the FAMILY LIBRARY as well as the school room.

INDEX.

PAGE.

A.

- Abdomen, 109
- Absorbents, anatomy of the, 277
  - physiology of the, 278
  - of the skin, 27
  - conditions of activity, 27–30
- Adipose tissue, 49
- Air, 118
  - quantity inhaled, 152
  - purity of, 153
  - influence upon skin, 44
- Air cells, 144
- Albino, 21
- Aorta, 182
- Arteries, anatomy of, 180
  - physiology of, 204
  - of the skin, 30
  - physiology of arteries, use of, 31
- Auricle of the heart, 176
- Asphyxia, from drowning, 293
  - from hanging, 294
  - from vapor of charcoal, 295

B.

- Bathing, 42
  - necessity of, 42
  - method of, 43
  - proper time for, 44
- Beds, 41
- Bile, 123
- Blood, 207
  - practical suggestions on the, 208
  - influence of, on the digestive organs, 134
  - effects of, upon the system, when impure, 161
  - change of, 146
- Bones, anatomy of, 50
  - physiology of, 70
  - of the head, 50
  - of the trunk, 55
  - of the upper extremities, 61
  - of the hand, 63
  - of the lower extremities, 64
  - of the foot, 66
  - composition of, 68
  - ossification of, 68
  - practical suggestions on the, 70
  - in children, 71
- Brains, anatomy of the, 211
  - injuries of, 306
  - membranes of, 211
  - physiology of, 216
  - practical suggestions on the, 217
- Bronchi, 144
- Bronchitis, how caused, 173
- Burns and scalds, 291

C.

- Cœcum, 116
- Capillaries, anatomy of, 199
  - physiology of, 204
- Cartilage, of the joints, 72
- Carbonic Acid Gas, 158
- Cellular Tissue, 48
- Caul, 120
- Cerebrum, 213
- Cerebellum, 215
- Chest, 140
- Chills, effect of, 37
- Chyme, 122

PAGE.

- Chyle, 123
- Circulation, 175
  - physiology of, 200
- Clavicle, 61
- Cœcum, 116
- Clothing, 37
  - amount of, 37
  - porosity of, 40
  - change of, 41
- Colds, 295
- Colon, 117
- Cuticle, anatomy of, 19
  - physiology of, 20
- Cutis Vera, anatomy of, 21

D.

- Death, signs of real, 312
- Deformities, 103
- Diaphragm, 88
- Digestive organs, 109
  - anatomy of the, 109
  - physiology of the, 122
  - practical suggestions on the, 125–139
  - effects of exercise on the, 132
  - influence of the mind on the, 133
  - influence of impure blood on the, 134
  - effects of position on the, 135
  - conclusions of Beaumont, 137
- Dislocation, management of, 305
- Drinks, 131
- Drowned, treatment of persons, 293
- Ducts, perspiratory, 47
- Duodenum, 113

E.

- Ear, anatomy of, 267
  - the external, 267
  - the middle, 268
  - the internal, 270
  - physiology of the, 273
  - practical suggestions on the, 275
  - extraneous bodies in the, 303
- Education of Children, 173
- Eye, anatomy of the, 255
  - physiology of the, 261

PAGE.

- Eye, appendages of the, 263
  - practical suggestions on, 266
  - extraneous bodies in, 304

F.

- Face, bones of, 52
- Falx cerebri, 213
- Fascia, 94
- Fat, 49
- Fingers, 63
- Flannel, 40
- Follicle, sebaceous, 47
- Food, quantity of, 126
  - quality of, 126
  - should be taken at stated periods, 127
  - should be taken in a proper manner, 131
- Fractures, management of, 305
- Freezing, 292

G.

- Gastric glands, 113
  - juice, 113
- Glands, lymphatic, 278
  - sudoriferous, 32
  - salivary, 109
  - of Peyer, 114
- Grief, effect of, on the lungs, 157
  - on digestion, 133

H.

- Hair, 45
- Hand, bones of, 63
- Heart, 175
  - anatomy of, 175
  - physiology of, 201
- Heat, animal, 288
- Hemorrhage, means of arresting, 297

I.

- Ileum, 114
- Intestines, small, 113
  - structure of, 114

PAGE.

- Intestines, large, 116
  - structure of, 118

J.

- Jaws, 52
- Jejunum, 114
- Joints, anatomy of, 72
  - physiology of, 77
  - practical suggestions on the, 78

L.

- Labyrinth, of the ear, 270
- Lacteals, 115
- Lachrymal glands, 264
- Larynx, 144
  - anatomy of, 164
  - physiology of, 165
  - practical suggestions on the, 169
- Ligaments, 72
- Light, influence of, on the system, 45
- Lymphatic vessels, anatomy of, 277
  - glands, anatomy of, 277
  - physiology of, 278
- Liver, 119
- Lungs, anatomy of, 142
  - necessity of ample volume of, 149
  - necessity of pure air to the, 158

M.

- Mediastinum, 144
- Mineral poisons, 308
- Mouth, 110
- Muscles, anatomy of, 79
  - of the face, 81
  - of the neck, 82
  - of the trunk, 84
  - of the upper extremities, 89
  - of the lower extremities, 92
  - physiology of, 96
  - practical suggestions on, 97–108
  - compression of, 98
  - over exertion of, 102
  - connection with the brain, 104

PAGE.

- Muscles, influence of mind on, 105
  - training of, 107

N.

- Nails, 46
- Nares, 253
- Nerves, cutaneous, 22
  - anatomy of, 22
  - physiology of, 23
  - agency of, 23–26
  - anatomy of spinal, 238
  - physiology of spinal, 242
  - sympathetic, 245
  - cranial, 227
  - anatomy of respiratory, 229
  - physiology of respiratory, 232
  - anatomy of the trifacial nerve, 234
  - physiology of the trifacial, 236
- Nose, 253
  - extraneous bodies in the, 304
- Nutrition, 285

O.

- Œsophagus, 111
- Omentum, 120
- Os Hyoides, 55

P.

- Pancreas, 119
- Parotid gland, 110
- Pericardium, 175
- Periosteum, 68
- Pericranium, 68
- Perspiration, 32
- Perspiratory Ducts, 47
- Pelitongs, 49
- Pelvis, bones of, 58
- Pharynx, 111
- Poisons, and their antidotes, 308
- Pulmonary artery, 180

R.

- Reading, proper position in, 170

PAGE.

Reading, how it should be taught, 173
Rectum, 117
Rete mucosum, anatomy of, 21
  physiology of, 21
Respiratory organs, 140
  physiology of, 146
  practical suggestions on, 149
  effects of grief on, 157
Retina, 256
Ribs, 55
  movement of ribs in respiration, 153

S.

Scapula, 61
Sacrum, 59
Salivary glands, 109
Saliva, its use, 122
Sebaceous follicles, 47
Secretion, 281
Secretory organs, anatomy of, 281
  physiology of, 282
Senses, 249
Sick-room, 307
Sitting, proper position in, 101
Sight, 255
Skeleton, 50
Skin, 19
  practical suggestions upon, 37
Sleeping rooms, ventilation of, 160
Smell, 252
  anatomy of organs of, 253
  physiology of smell, 255
Sound,
Speaking, proper position in. 170
Spinal column, 56
Sprains, 78
Spleen, 120
Spinal cord,
  anatomy of, 236
  physiology of, 242
Skull, bones of 51
Standing, proper position in, 100
Stammering, how cured, 171
Sternum, 57
Stomach, 112
St. Martin, Alexis, 128
Sweat glands, 32
Synovial membrane, 72

PAGE.

T.

Taste, 250
  physiology of, 252
Teeth, 53
Temperature of the system, by what modified, 38
Thoracic duct, 116
Thorax, bones of, 55, 140
Throat, extraneous bodies in, 304
Tight lacing, effects of, 154
Toes, bones of, 66
Tongue, 257
Tonsils, 172
Touch, 249
Trachea, 144
Tumors, adipose, 49
Tympanum, 268

U.

Uvea, 258

V.

Valves of the heart, 177
Valvulæ conniventes, 114
Vapor bath, 43
Vasa Vasorum, 181
Veins, anatomy of, 193
Vegetable poisons, 311
Ventilation, 160
Ventricle, right, 178
  left, 179
Vertebræ, 57
Voice, where formed, 164
Vocal cords, 166

W.

Waste, 126
Wind-pipe, 144
Wounds, treatment of, 300
Writing, 108

ANATOMY AND PHYSIOLOGY.

CHAPTER I.

ANATOMY is the term applied to the description of the mechanism or structure of the parts of the system. It is derived from the Greek *ana*, through, and *temnô*, I cut; which signifies the art of dissecting, or artificially separating the different parts of the animal body.

PHYSIOLOGY is the science of the properties and functions of animals and plants. It is derived from the Greek *phusis*, nature, and *logos*, a discourse.

HUMAN PHYSIOLOGY treats of the laws by which the various functions in man are carried on.

COMPARATIVE PHYSIOLOGY treats of the functions of other animals than man, with a view to compare their structure with that of human beings.

VEGETABLE PHYSIOLOGY treats exclusively of plants.

The kingdom of nature is divided into organic and inorganic bodies. *Organic* or animate bodies are such as possess organs, on the action of which depend their growth and perfection. This division includes animals and plants.

Inorganic, or inanimate bodies, are devoid of organs, or instruments of life. In this division are classed the earths, metals, and other minerals.

What is anatomy? What is it derived from? What is physiology? What is it derived from? What does human physiology treat of? What does comparative? What does vegetable physiology? Define organic bodies. What does this division include? Define inorganic bodies. What are classed in this division?

In general, organic matter differs so materially from inorganic, that the one can readily be distinguished from the other. In the organic world, the parts are mutually dependent on each other for support. Break the tiny stem of a rose, and it soon withers; or girdle the bark of the forest tree, and it dies, because it cannot receive support from the ascending sap. So in man: amputate an arm, and its vitality ceases, for the vessels communicating with it have been severed. But in inorganized bodies, the results are different. Break off a piece of flint, and it is exempt from those internal changes and effects which impair, and finally destroy organic structure and arrangement.

'Organized bodies always present a combination of both solids and fluids; — of solids differing in character and properties, arranged into organs, and these endowed with peculiar functional powers, and so associated as to form of the whole a single system; — and of fluids, contained in these organs, and holding such relations to the solids, as that the existence, the nature, and the properties of both, mutually and necessarily depend on each other.

' Inorganic bodies exist in solid, liquid, or gaseous forms; yet every inorganic body consists wholly either of the solid, or liquid, or gaseous form of matter; and all its parts are alike in structure and properties, and may exist as well when separated into portions or broken into fragments, as when united in a single volume or mass. But whether solid, liquid, or gaseous — whether composed of one or more of the chemical elements, the aggregations and arrangements of the atoms of matter in every substance, take place according to fixed constitutional laws, and in a regular and determinate manner; so that the intimate structure of each form of matter is always true to its own nature. Still, however, the constitutional laws of aggregation in organic bodies, do not define the shape nor determine the size of the general mass, and therefore, while their molecular arrangement is always strictly de-

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Can organic and inorganic bodies be readily distinguished from each other? Show the mutual dependence of parts in the organic world? How is it in the inorganic world? What do organized bodies always present? In what forms do inorganic bodies exist? What distinctive difference between inorganic and organic bodies?

terminate, their general mass is either regular or irregular in shape, and large or small in size, according to circumstances, and the action of accidental causes; and, without in the least degree affecting their nature or properties.'

Organized bodies increase in size by a process called nutrition, which consists in imbibing substances and converting them to their own nature, by means of internal organs. They have, within a certain range, their specific proportions, shape, and size, by which they are not only distinguished from inorganic bodies, but specifically from each other. Inorganic bodies, on the contrary, increase in size, or change in shape, by the simple accretion of matter to their surfaces. Thus it will be seen that organized bodies augment in bulk from within, and inorganized bodies from without.

Though animals and vegetables derive their origin from pre-existing bodies of the same kind, and possess the faculties of nutrition and reproduction, yet the animal kingdom is as distinct from the vegetable, as the latter is from the mineral kingdom. The fundamental endowments which distinguish animals from vegetables, are *sensation*, and *voluntary* motion. The latter are destitute of these qualities. If animals had no sensibility, they would not know their wants: if they had not, combined with this, the power of motion, they could not supply those wants. Another characteristic of animals, is a predominance of fluid over the solid parts. This causes them to decompose sooner than vegetables; and common observation shows, that those plants which abound in fluids decay sooner than those of a more fibrous or solid texture.

Vegetables are nourished by the substances immediately around them, — as air, water, and the saline properties of the soil. Their support is drawn from without, by absorption at their surface, or by means of roots. Animals, on the contrary, derive their nutriment from a great variety of sources. The aliments, previously to being absorbed and diffused through the different parts of the

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How do organized bodies increase in bulk? Inorganic? Do animals and vegetables differ? What are the fundamental endowments which distinguish animals from vegetables? What is another characteristic of animals?

body, to afford nourishment to the organs, are received into an internal cavity, which prepares it for nutrition.

The differences between the animal and vegetable kingdom, are in general sufficiently obvious, but in some few instances, their distinguishing characteristics are not so evident. In the lowest order of animals, as the sponge, coral, &c.; we find them to be as firmly attached to the soil, as most vegetables; while on the other hand, some vegetables float in the water, as many kinds of sea-weed, and are never attached to the soil.

Every function of the animal frame has its legitimate sphere of activity; — but all may be abused; — and, it is impossible systematically to avoid abuse of them, except by being instructed in their nature and relations.

Has every function of the animal frame its legitimate sphere of activity.

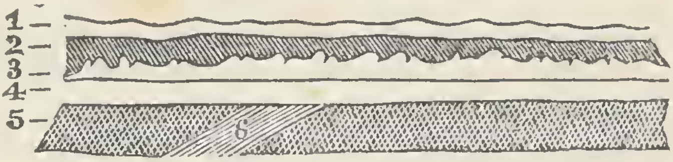
CHAPTER II.

ANATOMY AND PHYSIOLOGY OF THE SKIN.

THE SKIN is a membranous covering, enveloping the bones and other parts of the system. In youth, and in females particularly, it is smooth, soft, and elastic. In middle age and in males, it is firm, and rough to the touch. In old age, in persons who are emaciated, and about the flexions of the joints, it is thrown into folds.

The skin, to the eye merely, appears composed of one membrane. But investigation has shown, that it consists of three layers of membrane: viz. the *cuticle*, or *scarf skin*, the *rete mucosum*, or *mucous coat*, and the *cutis vera*, *corion*, or *true skin*, — combined, they form the animal membrane, the skin. The following engraving represents the relative position of the several layers of the skin.

Fig. 2.



1, The cuticle, or scarf skin. 2, The rete mucosum, or colored stratum of the skin. 3, The papillæ on the surface of the true skin. 4, Cutis vera, or true skin. 5, The subcutaneous cellular tissue. 6, some fibres of the cutaneous muscle.

ANATOMY OF THE CUTICLE.

The CUTICLE, from the Latin, *cuticula*, is the external layer of the skin; it is also called the *epidermis*. This membrane is thin and semi-transparent, and resembles a thin shaving of soft, clear horn, and bears the same relation to other parts of the skin, that the rough bark or ross of a tree does to the liber or living bark. The cuticle has

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What is the skin? How does it appear in its different conditions in the human frame? How many layers of membrane has it? What are they? What does Fig. 2 represent? Describe the *cuticle*.

no perceptible nerves or blood vessels; consequently, if it be cut, or abraded, no pain will be felt, nor fluid ooze from it.

We find this membrane to vary in thickness in different parts of the system, from the thin delicate skin upon the internal flexions of the joints, to the thickened covering of the soles of the feet. The greater thickness of the cuticle of the palms of the hands, and soles of the feet, is manifestly the intentional work of the Creator; for it is perceptible in infants, even at birth, before exercise can have had any influence.

Friction, if moderate, and repeated often, will increase it in thickness, as may be seen in the thickened cuticle of a lady's finger that plies the needle, and in the almost horny hardness of the hands of farmers, masons, and other mechanics.

When the scarf skin is removed by friction, hot water, or blistering salve, it is speedily restored. The material for restoring the cuticle is secreted from the blood that circulates in the skin. This work of reparation is effected by the action of the cutaneous vessels; and, by a similar action on the part of these vessels, this tissue is thickened, as seen in the mechanic's hand.

PHYSIOLOGY OF THE CUTICLE.

The CUTICLE is supposed, by some, to be a secretion from the cutis vera, which concretes on the surface, becomes dry, and thereby serves as a shield to the delicate nervous expansion of the subjacent parts of the skin. Were the nervous tissue of the skin not thus protected, every sensation would be unpleasant, and contact with external bodies would cause pain. Divested of this protection, we should be disabled for exertion. The cuticle also impedes the evaporation of the fluids of the skin, and the absorption of poisonous vapors, which necessarily attend various employments,—thus preventing disease. It, however, affords protection to the system only when *unbroken*.

Has it any blood vessels or nerves? What result from the absence of them? Does the cuticle vary in thickness in different parts of the system? What reason have we to think this provision intentional? What effect has friction upon it? When it has been removed, how is it renewed? What is the cuticle supposed to be by some physiologists? What protection does it give? When does it prevent disease?

ANATOMY OF THE RETE MUCOSUM.

The RETE MUCOSUM, from the Latin, *rete*, a net, and *mucus*, lies immediately beneath the cuticle. This is the coloring tissue of the skin. In the African, it is black; Mongolian, yellow; Indian, copper colored; Caucasian, white. Its surface is rendered irregular by numberless extremities of the nerves of sensation, which ramify under it, producing also a corresponding roughness of the cuticle. These nerves are arranged in parallel, irregular rows, that are distinctly seen on the ends of the fingers, and palms of the hands.

PHYSIOLOGY OF THE RETE MUCOSUM.

When the coloring matter of the RETE MUCOSUM is entirely absent in individuals, we observe that peculiar whiteness of skin which marks the Albino; and it is remarkable in such cases, that the iris, or colored border of the eye, has a bright red tint, and the hair is rendered snowy white, by the same general cause. In scrofulous constitutions, the deficiency of this deposit renders the complexion, the eyes, and the hair, light. An excess produces the dark skin, black eyes, and hair of the brunette.

It is a well known fact, that men of tropical climates are of a darker hue than those of the temperate. The same is true of the animals of the torrid zone.

This membrane gives protection and serves as a shield to the nerves of sensation. May not the coloring matter of this tissue protect those organs lying beneath, from too powerful action of heat? It is in this membrane that the high and almost metallic color of several kinds of fish is placed.

ANATOMY OF THE CUTIS VERA.

The CUTIS VERA, from the Latin, *cutis*, the skin, and *vera*, true, is the inmost layer of the three membranes. It is composed, chiefly, of gelatine. This, in a liquid state, is known by the name of jelly; when solid, it is called glue. It is this part, also, which forms leather, when united with the tannin extracted from the bark of the hemlock or oak. In the different races of men, as well

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Describe the *rete mucosum.* What appearance has its surface? What causes the peculiar complexion of the Albino? What does an excess of this coloring matter produce? What is the use of this membrane? What is the third or inmost layer of the skin called? Of what is it chiefly composed?

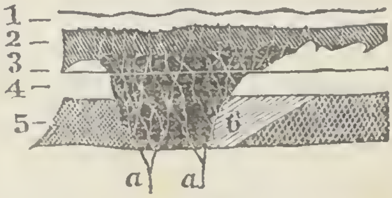
as in various species of colored animals, the cutis vera consists of the same principle. Were the skin of the Mongolian or Caucasian subjected to the process of tanning, it would produce leather similar in texture to that obtained from animals. Unlike the cuticle, the *cutis vera*, if destroyed, is never restored, which causes the scars that follow deep wounds and burns.

This membrane consists of a multitude of minute vessels, which cross each other in every direction. These form a kind of net-work of the finest conceivable texture. The vessels of the cutis or skin, are the *nerves*, *absorbents*, *arteries*, *veins*, and *sudoriferous* or *sweat* glands.

ANATOMY OF THE CUTANEOUS NERVES.

The NERVES, from the Latin, *nervus*, are spread over every part of the true skin. As a proof of this, no part of this tissue can be punctured with a fine needle, without transfixing a nerve, and inducing pain. In some parts of the system, the nerves are more abundant than in others: where the sense of feeling is most acute, we find the greatest number of nerves, and those of the largest size. They are more numerous in the upper, than lower extremities; in greater numbers upon the palm, than the back of the hand. They are, likewise, more abundant and larger at the extremities of the fingers, and in the lips, than in any other part of the body. The proboscis of the elephant, the extremities of the tails of certain species of monkeys, and the tentacula of some kinds of fish, receive a more abundant supply of sensitive nerves than other parts of their systems.

Fig. 3.



1, The cuticle, or scarf skin. 2, The rete mucosum, or colored stratum of the skin. 3, The papillæ on the surface of the true skin. 4, Cutis vera, or true skin. 5, Subcutaneous cellular tissue. 6, Some fibres of the cutaneous muscle. *a*, *a*, Two nerves divided into numerous filaments, passing through the true skin, and ramifying under the cuticle.

How does it differ from the cuticle? Of what does it consist? Name the vessels that traverse this membrane. Describe the cutaneous nerves. How is their existence proved? Where are they found in greatest numbers? What is the design of Fig. 3?

PHYSIOLOGY OF THE CUTANEOUS NERVES.

It is a law of the animal economy, that parts unlike in their structure, are different in their functional operations. This is illustrated by the different structure and functions of the eye and ear. As the *nerves* differ from the other vessels and parts of the skin in structure, so we find a difference in their use or functions. An artery contains blood: if its coat be broken, the blood will flow from the wound. A nerve contains no blood, but it is the channel of communication between the parts upon which its minute filaments ramify, and the brain—the centre of sensation and seat of the mind. If a filament of any nerve of sensation be wounded, the impression made upon it is communicated to the brain, and the mind becomes sensible of the injury of the nerve. In the one case, if a blood vessel is wounded, and no sensitive nerve is touched, there will be bleeding, but no pain. In the other case, if a nerve be wounded, and no blood vessel is divided, there will be pain, but no bleeding

The nerves of the skin are of importance to us in two ways: 1st. Through them we receive many impressions that enhance our pleasures; as, the grateful sensations imparted by the cooling breeze in a warm day. 2d. In consequence of the sensitiveness of the nerves, we are individually protected, by being admonished of the proximity of destructive agents, and the destruction induced by them. This is illustrated by an incident related by Dr. Yelloly, in the 3d vol. of the Medico Chirurgical Transactions. A man who had been afflicted some years with a severe disease of a portion of the brain and spinal cord, was deprived of feeling in the lower extremities. He was directed by his attending physician to use a warm foot-bath. Following the directions given him, he immersed his feet in boiling water, which he supposed of a proper temperature. While his feet were immersed in the water, he experienced no sensation of an unpleasant nature. On withdrawing them, he was astonished to find the scarf skin separated from the other tissues, by the effusion of water or serum, and thus producing a blister

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What law of the animal economy is here given? How illustrated? Of what importance are the nerves of the skin? What illustration is given?

over the whole surface. Portions of the skin would suffer every day, were it not for the sentinel-like care exercised by the nerves. Impressions upon them are transmitted to the brain with as much speed and readiness, as the communications by the Electro Telegraph of Prof. Morse.

As the skin is continually exposed to the influence of destructive agents, it is important that the sentient nerves, provided for its protection, should be kept in a healthy state. The sensitiveness of the skin is effected by the following conditions. 1st. *The healthy or unhealthy, active or inactive state of the brain.* In sound and perfect sleep, the brain is inactive. In this state, ordinary impressions made upon the skin, are not observed by the sleeping person. Thus the arm may be blistered while sleeping, if it is exposed to the warm rays of the sun, and the individual will not be aware of it at the time. If there is compression of the brain, as when the skull bones are depressed, or disease of this organ, as in severe typhus fever, impressions made upon the sentient nerves of the skin will not be noticed, as the operations of the mind are suspended under such circumstances.

The varying health or condition of the brain, usually depresses or increases the sensitiveness of the skin. This is seen in *grief* and *fear*, which diminish, while *hope* and *joy* increase the impressibility of this tissue. It is not uncommon to see the unfortunate insane endure exposure to heat and cold with seeming impunity; whereas it would induce almost insupportable suffering to the sane man. Diseases of the heart, stomach, and lungs, alter the condition of the brain, and modify, to a greater or less degree, the sensitiveness of the skin.

2d. *The state of the conducting, nervous trunks influences the sentient nerves.* If a nervous trunk be compressed, or divided, the parts supplied by nervous filaments from the nerve, will be insensible to the impressions made upon

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Why is it necessary that the sentient nerves be kept in a healthy state? What is the first condition upon which their health depends? Are ordinary impressions noticed in perfect sleep? Why not? When the brain is compressed? Upon what does the sensitiveness of the skin depend? What effect have mental emotions upon the skin? Do diseases of the other organs affect the sensibility of the skin?

them, and such impressions are not transmitted to the brain.

3d. The quantity and quality of the blood modify the sensitiveness of the skin. If the quantity of the blood be diminished, the sensibility of the skin will be impaired. This is demonstrated by noting the effects of cold upon the cutaneous tissue, the application of which contracts the blood vessels, and drives the circulating fluid from this tissue, which is shown by the paleness, as well as by the shrivelled appearance of the skin. And if this tissue be wounded while under the influence of cold, little or no blood will exude from the divided blood vessels, and but little pain will be felt. The chilling and contracting influence of cold upon the blood vessels can be carried so far as not only to deprive the part of sensation, but of life.

The influence of the blood upon the sensibility of the skin is further demonstrated by the pain experienced when chilled extremities are suddenly exposed to heat. The nerves, by the sudden dilatation of the contracted blood vessels, are put in vivid and rapid motion, which causes the painful and tingling sensation that we experience. In every part of the system, sudden changes produce unpleasant sensations, and, frequently, a diseased condition of the organs. Thus we may assert, that *all changes, to be either safe or pleasant, must be gradual.* When the hands are frozen, or severely chilled, safety and comfort demand that circulation be invited to the parts by moderate exercise in a cool room. Immersing the parts in warm water, or holding them near the fire, causes pain, and frequently destroys the vitality of the limb. If the quality of the blood be impure, as when a person has breathed vitiated air, the sensibility of the skin will be impaired.

4th. The condition of the cuticle modifies the impression made upon the cutaneous nerves. 1st. When the cuticle has

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What is the second condition upon which the sensibility of the skin depends? What the third? What effect has the diminution of blood upon the skin? Illustrate it. How is the influence of the blood upon the skin further demonstrated? What causes the painful, tingling sensations, when we expose chilled limbs to heat? Should all changes in the animal economy be gradual? Why? What is the fourth condition upon which the sensibility of the skin depends?

become thick and hard like horn, as it frequently does in the inside of the mason's hand, and others of similar trades; it enables them to ply their tools without much suffering, because the thickened cuticle diminishes the impressions made upon the nerves. 2d. When the cuticle is very thin and delicate, as in the hand of the lady who is unaccustomed to manual labor. Let her pursue some manual avocation for several hours, and the extreme tenuity of the epidermis will not protect the nerves and parts below from becoming irritated and inflamed; consequently, pain and blisters will be the inevitable result. 3d. When the cuticle is removed by vesication, or abrasion, the pain indicates that the naked nerves are too powerfully stimulated by the contact of external bodies.

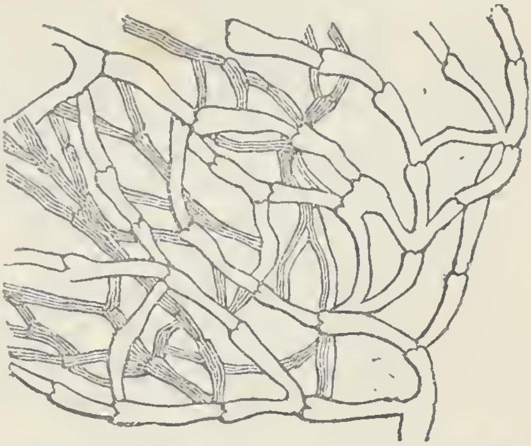
5th. The sensibility of the cutaneous nerves is modified by being habituated to impressions. If, for example, an individual should immerse his feet in moderately warm water: at first, it might induce a smarting sensation; in a short time the nerves would not only become habituated to the *warm* water, but its warmth might be considerably increased. The same results follow, if an individual be exposed to cold. The impressions at first are highly disagreeable, but as soon as the nerves become accustomed to the surrounding atmosphere, they will impart to the mind agreeable sensations. To illustrate this, let a person from the tropical regions go to a colder climate, and the cool mornings of the latter will at first affect him unpleasantly; but after a few days' exposure to the cooler air, the sensation will be far from being disagreeable. Take an opposite illustration. Let a person enter a room moderately heated; gradually increase the temperature, until it attains extreme summer heat; not only the cutaneous nerves, but the whole system becomes habituated to the high temperature. From these facts we learn that the sensations are not always a correct index of the real temperature. A well-adjusted *thermometer* is the agent that will indicate it with unerring certainty.

What is the fifth condition on which the sensibility of the cutaneous nerves depend? Illustrate it. Are the feelings an index of warmth or coldness?

ANATOMY OF THE CUTANEOUS ABSORBENTS.

The ABSORBENTS of the skin are numerous, and so minute that they cannot be seen with the naked eye: but when these hair-like vessels are injected with quicksilver, (a work of great difficulty,) the surface injected resembles a sheet of silver. In this way their existence can be imperfectly demonstrated. They are also called *lymphatics*, from the Latin, *lympha*, a colorless fluid.

Fig. 4.



This engraving represents a plexus of *lymphatic* or *absorbent* vessels in the skin, considerably magnified from an injected preparation.

PHYSIOLOGY OF THE CUTANEOUS ABSORBENTS.

Though some physiologists ascribe but little importance to cutaneous absorption, yet the experiments of Dr. Edwards prove, without a doubt, that when certain conditions of the skin exist, the process of absorption is carried on with great vigor. 1*st. This is most vigorous when the cuticle is removed by vesication or blistering.* Then, external applications are brought in immediate contact with the orifices of these vessels, and rapidly circulated through the system. Thus arsenic applied to the cutaneous vessels, and strong solutions of opium to extensive burns, have been absorbed in quantities sufficient to poison the patient.

The same results follow if the cuticle is only punctured or abraded. The highly respected Dr. W——, of Boston, lost his life by poisonous matter from the body of a patient subjected to a post mortem examination. He had re-

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What is said of the *absorbents*? How is their existence proved? What does Fig. 4 represent? When are the absorbents most active? Relate the incident of Dr. W——, of Boston.

moved from his finger, previously to the examination, a 'hang-nail,' and the poison from the dead body was brought in contact with the part denuded of cuticle, and through the agency of the absorbents it was conveyed into the system. Puncture any part of the scarf-skin with the finest instrument, that has upon its point the smallest conceivable quantity of the small-pox matter, or the *vaccine virus*, and it will be brought in contact with the absorbent vessels, and through their agency conveyed into the system. The result is, that persons thus operated upon, have the small-pox, or the vaccine disease.

In removing the skins from the bodies of animals that have died of disease of any kind, and in handling or managing sick persons or animals, see that the scarf-skin is not broken or otherwise injured; safety and health require this caution. When we expose ourselves to poisonous vapors, observe the same caution. It would be beneficial to tanners, curriers, and those who handle substances that may contain poisonous animal matter, to have definite information on this topic. We have known many instances where tanners have had the poisonous animal matter upon hides, introduced into their systems, by having small ulcers upon their fingers or hands. From these sores, there would be seen small red lines extending up the arm. These swelled tracts indicate an inflammation of the large absorbent trunks, that have been irritated and diseased by the passage of poisonous matter through them into the system.

In case of an accidental wound, immediately bathe the part thoroughly in pure water, and avoid all irritating applications. In some instances, it would be well to apply *lunar-caustic* immediately. When handling the dead bodies of friends, or removing the skin from animals that have died of disease, it would be well to lubricate the hands with olive oil or lard. By so doing the minute portions of the skin from which the cuticle had been removed, would be protected by being covered. It has been observed in countries where the plague prevails, as in Turkey and Egypt, that oil dealers and fish-

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What precaution is necessary in removing the skin from animals that have died of disease? Have persons ever been injured for want of this caution? What directions are given when the cuticle is broken?

ermen, whose bodies are continually lubricated with oil, do not readily contract the disease. This is owing in part to the oil filling the minute orifices of the skin. In all cases where there is an ulcer or sore, cover the part with some kind of cloth before exposing the system to any animal, vegetable, or mineral poison.

2d. *An inactive state of the lacteals of the digestive organs increases the cutaneous absorption.* This attends two conditions of the digestive organs. 1st. When they are diseased so that food cannot be given with propriety. 2d. When they are healthy, and a due amount of aliment is not taken at proper intervals.

3d. *Moisture and warmth stimulate the absorbents to action.* It is a law of organized bodies, that they act most effectively when excited by an appropriate stimulus. Among the organs of the system, as well as among different individuals, action or effort is induced by different stimulants. Thus one person may be induced to make effort from love of approbation; another, from love of money; a third, from pride. So one set of vessels in the skin is excited to action by the stimulus of blood; another is induced to act by moisture and warmth; a third is excited by a warm and dry state of the skin and air. Let us apply these positions in practice. Suppose several members of a family are prostrated with a disease that may be communicated from one person to another. It is of importance that those of the family who are in health, and others whom the voice of humanity impels to perform the office of assistants, as watchers or nurses, should be prevented from contracting the disease. Formerly the attendants were excluded from all intercourse with others; alcohol, with decoctions of bitter herbs, was used; tobacco was chewed, smoked, and snuffed. But these practices avail but little, as the *virus*, or matter generated in the organs of the diseased person, is conveyed into the system of the attendant, by the action of the absorbents. And narcotising the system with alcohol and tobacco does not diminish the activity of these vessels.

What is the second state upon which the activity of the absorbents depends? Upon what two conditions of the digestive organs does this state depend? What law of organized bodies is given? What was the former practice for preventing the system from contracting diseases? Was the former method of narcotising the system of advantage?

If the absorbent vessels are rendered inactive, diseased matter will not be introduced into the system by them, and individuals who note this precaution can enter these rooms with comparative safety. This state of the vessels is induced by observing the following directions. 1*st.* Supply the stomach with *food* of a *nutrient* and *digestible* character, in proper quantities, at proper times, and at stated periods. As the chyle formed from the food stimulates to activity the lacteals of the digestive organs, which activity is attended with an inactive state of the absorbents of the skin and lungs, for this reason due attention should be given to the food of nurses, watchers, and also the children in the family where there is sickness.

2*nd.* Keep the skin *dry* and *clean.* Hence, the necessity of a frequent change of the wearing apparel, and attention to the ventilation of the apartment of the sick. If due attention be not given, the clothing and air of the room will become moist by the exhalations from the skin and lungs. This exhalation may contain a poison of greater or less power, according to its quantity and degree of concentration, and may be absorbed and reconveyed into the system, causing inflammatory diseases, and not unfrequently death. In visiting the unhealthy districts of the South and West, by taking a supply of food at proper periods, keeping the skin and clothing in a clean state, the house well ventilated, and avoiding the damp chills of evening, the liability to contract disease is much lessened.

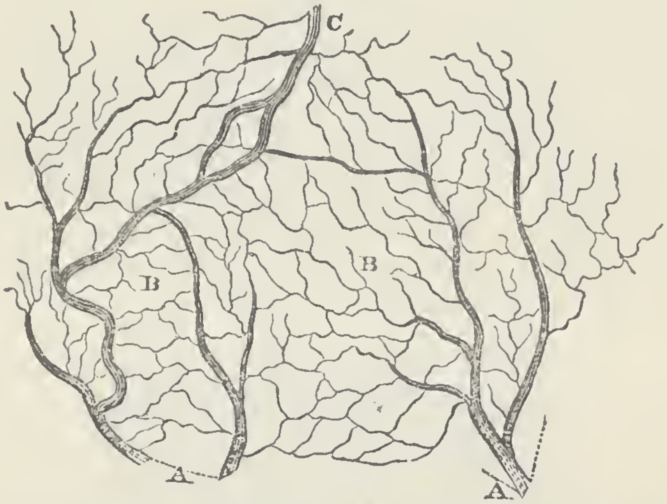
ANATOMY OF THE CUTANEOUS ARTERIES.

The ARTERIES, from the Greek, *arteria,* are small tubes or vessels, through which the scarlet or pure blood passes. The larger arteries are subdivided into innumerable and very minute tubes, called capillary vessels. These are spread over every part of the skin, which, through their agency, is supplied with nutrient blood. They open into and terminate in minute veins.

What is a necessary condition of the absorbents to prevent contracting disease? How can this state of the vessels be induced? What precaution in regard to the clothing? What respecting the state of the air? What precautions are given in removing to climates different from our own? What are *arteries*? How is the skin supplied with nutrient blood?

The VEINS, from the Latin, *vena*, are the vessels that convey blood to the heart. The minute veins unite to form larger trunks, as small springs from the hill side coalesce to form rivulets.

Fig. 5.



This engraving represents the arteries and veins of a section of the skin. A, A, arterial branches; B, B, capillary or hair-like vessels, in which the large branches terminate, C, the venous trunk, collecting the blood from the capillaries.

PHYSIOLOGY OF THE CUTANEOUS ARTERIES.

The circulation of the blood through the veins and arteries of the skin, is most energetic under the following circumstances. 1. When the heart acts with vigor. 2. When the system contains a proper amount of healthy blood. This is illustrated by the paleness of the skin, which follows the loss of large quantities of blood. 3. When the muscles and limbs have been properly exercised. This is illustrated by the absence of the paleness that usually attends a person of sedentary habits, and the substitution of the carnation glow of health, while riding or walking in the open air. 4. When the brain and nervous system are in a healthy state. This is seen when we compare the flushed cheek of a person who is stimulated by hope and joyful expectations, with the ashy paleness of the unfortunate person who is depressed by grief. The influence of the mind upon the circulation of the skin, is also seen in the instantaneous suffusion

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Describe the *veins* of the skin. What does Fig. 5 represent? When is the circulation in the skin most energetic? Does joy or grief have any effect upon it?

in blushing. There, the minute arteries of the skin, through which the lymph or white blood usually passes, become suddenly dilated and filled with red globules of arterial blood. 5. When the skin is kept of proper temperature. This is seen by comparing the pallid, contracted, and wrinkled appearance of the skin, when exposed to cold, with the smooth, full, and increased color of the part, that attends and follows the application of heat. 6. When the arteries and veins are not compressed by clothing, or by any other means. This is illustrated by the paleness produced when the skin is compressed by the finger or hand, which prevents the blood from passing through the arteries. Let the pressure be removed, and the color returns by the circulation being restored.

ANATOMY OF THE SUDORIFEROUS GLANDS.

The SUDORIFEROUS, or SWEAT GLANDS, are small organs situated among the fat vesicles beneath the skin. They are supplied with arteries, veins, and nerves. These glands exist in great numbers, and are so minute that they cannot be examined without the aid of a microscope.

PHYSIOLOGY OF THE SUDORIFEROUS GLANDS.

By the agency of this peculiar and complicated apparatus, the exhaled matter which is carried off through the skin, is separated from the blood. This exhalation amounts to a considerable quantity every day. SANCTORIUS experimented upon himself for more than thirty years, weighing himself, his food, and the excretions thrown out, daily. He estimated that *five* of every *eight* pounds of food and drink, passed from the system through the many outlets upon the skin. Many place the estimate much lower. All physiologists concur that from twenty to forty ounces of matter pass off from the skin of an adult, in the form of insensible perspiration, every twenty-four hours. To prove the existence of this exhalation, take a bell glass, or ipecacuanha vase, and let a hand, perfectly dry, be introduced into it; at the same time

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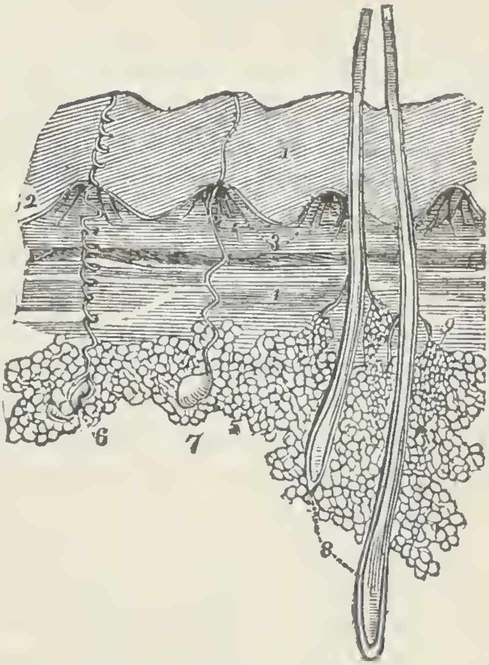
What effect has compression upon the arteries? What are the *sudoriferous* or sweat glands? Are these glands numerous? How is the exhaled matter separated from the blood? Mention the experiments of *Sanctorius*. What was his estimate? What is the amount of waste matter which passes from the system every twenty-four hours?

close the mouth, by winding a napkin about the wrist. In a short time the insensible perspiration from the hand will be seen deposited on the inside of the glass. At first the deposit is in the form of mist; but if the experiment be continued a sufficient time, it will collect in drops. When the circulation of the blood is increased by exercise, or after drinking warm fluids, as teas, it appears in the form of sensible perspiration. This vapor or perspiration contains the decayed and useless matter which is carried out of the system by the sudoriferous glands.

Fig. 6.



1, The cuticle, showing the oblique laminæ, of which it is composed, and the imbricated disposition of the ridges upon its surface. 2, The rete mucosum. 3, Two of the quadrilateral papillary masses, such as are seen in the palm of the hand or sole of the foot. 4, Cutis vera. 5, Adipose vesicles; showing their appearance beneath the microscope. 6, A perspiratory gland with its spiral duct, such as is seen in the palm of the hand or sole of the foot. 7, Another perspiratory gland with a straighter duct, such as is seen in the scalp. 8, Two hairs from the scalp, enclosed in their follicles; their relative depth in the skin is preserved. 9, A pair of sebaceous glands, opening by short ducts into the follicle of the hair.

The waste material, which proceeds from the bones, muscles, fat, and other parts of the system, is replaced by newly prepared atoms from the nutrient food.—Thus there is a constant decay and renovation of the system. As an illustration of this, feed two domestic animals with food colored with madder, or any other

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How can this be perceived? What does Fig. 6 represent? From what does this waste matter proceed?

coloring matter, and on killing one at the end of four weeks, the bones will exhibit a reddish hue; withdraw the colored food from the other animal a few weeks before killing it, and the bones will be white,—a proof of the ever-changing state of the system. We may say with truth, that, to a certain extent, the power of making our systems healthy or unhealthy, is at the disposal of each individual.

The appropriate stimulus of these glands should be known, as the health of the system depends on their efficient action. 1st. These glands act with more vigor the first three hours after eating than during the subsequent hours of inanition; showing that the system should be supplied with food in proper quantities and at due intervals. 2d. They are more active during sleep; this points to the necessity of regularity in our hours of repose, and also thorough ventilation of the bedding every morning. 3. Dry, porous clothing should be loosely worn, that the serous or watery part of the waste matter may escape freely, and if the saline and animal elements are not removed by frequent bathing and friction, the mouths of the sudoriferous ducts will become obstructed.

When the surface of the body is suddenly exposed to cold, or when the chill of fever exists to a considerable degree, the skin will contract very sensibly; and, at the same time, a great number of conical papillæ will project from its surface. This constitutes the *cutis anserina*, or *goose flesh*, and is supposed to be produced by a sudden contraction of the vessels in the skin, which forces out their contents, and consequently diminishes their bulk, while the papillæ do not contract in the same degree, and therefore are somewhat projected. The sudoriferous ducts become contracted when this state of the skin exists; this impedes the vigorous action of the perspiratory glands, and the free escape of perspiration. For this reason, sudden exposures to cold should be carefully avoided.

Not only is the waste matter carried from the system by the perspiratory process, but the *temperature of the system is modified and regulated by the evaporation of fluids*

How is the ever-changing state of the system illustrated? Mention the conditions which cause the sudoriferous glands to act most efficiently. What causes the *cutis anserina*, or *goose flesh*? How is the temperature of the system modified and regulated?

from the skin and lungs. It is well known, that, in the polar regions, and in the torrid zone, under every variety of circumstances, the human body is nearly of the same temperature, however different may be that of the air with which it is surrounded. This is a property peculiar to life, and, in consequence of which, even vegetables have a power of modifying, although in a less degree, their own temperature. Without this power of adaptation, it is obvious that man must have been chained for life to the climate which gave him birth, and also have suffered constantly from change of seasons; whereas, by possessing it, he can retain life in a temperature sufficiently cold to freeze mercury, and sustain unharmed for a time, a degree of heat more than sufficient to boil water, or even to bake meat. In all ages and climes it has been observed that the increased temperature of the skin and system, in fevers, is abated as soon as free perspiration is restored. In the sultry days of July and August, the disagreeable sensation of heat subsides as soon as the atmosphere becomes clear and dry, or a free perspiration is established, for the reason that heat is abstracted from the system to convert the serous part of the perspiration into vapor.

In warm climates, the skin when in health is constantly bedewed with perspiration, the evaporation of which reduces the temperature of the system, and produces the grateful sensation of coolness. When free perspiration exists, a corresponding appetite for drinks exists, to repair the waste of fluids which attends copious perspiration.

It is frequently noticed, in very warm weather, that dogs and other domestic animals are seen with their tongues lolling out of their mouths, and covered with frothy secretions. This is merely another modification of reducing animal heat, as the skin of such animals does not perspire as much as that of man.

It is on the principle of the evaporation of fluids, that warm vinegar and water applied to the burning, aching

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What is said of the temperature of the human system in various climates? Why the sense of coolness in fevers when perspiration is established? Why are we more thirsty in a warm, than a cold day? What will you say of the frothy secretions seen about the mouths of dogs and other animals? Why do warm liquids applied to the skin in fevers, impart a sensation of coolness?

head, cools it, and imparts a feeling of increased comfort. The same results follow, if warm liquids are applied to the skin in the hot stage of fever.

When an individual has been thrown into a profuse perspiration, by violent exercise, though the skin and clothing may become wet, he feels no inconvenience from the dampness, as long as he continues that amount of exercise; for the reason, that increasing the circulation of the blood, heat is generated in sufficient amount to convert the sweat into vapor; but, as soon as the exercise is discontinued, the increased circulation subsides, and with it the extra amount of generated heat. This accounts for the chill we experience, when the clothing being damp, is permitted to dry on the body.

When the clothing has become wet, it is best to change it *immediately*, and rub the skin with a dry, crash towel, until reaction, indicated by redness, is produced. If the garments are not changed, gradually abate the exercise, that sufficient heat may continue to be generated in the system to dry the clothing and skin. By all means, avoid sitting in a cool shade, or current of air; as colds are not contracted by free and excessive exercise, but by injudicious management after such exercise.

If, between twenty and forty ounces of waste matter pass through the outlets of the skin every twenty four hours, it is important that this excretion be maintained with steadiness and regularity. When the action of the sudoriferous glands is suppressed, all the vessels of the different organs will suffer materially, and become diseased by the redundant waste matter that should be carried from the system. If a person is vigorous, the organs, whose functions are similar to those of the skin, as channels for the exit of waste matter, will have their action increased, and thus relieve the diseased state of the system. But the over-taxing of these organs to relieve the system, often produces a diseased action in themselves.

Many cases of chronic coughs, headache, dyspepsia, diarrhœa, originate in this way. If any one organ of the system has been weakened, this organ is more suscepti-

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How is the chill that we feel after exercise has been discontinued, accounted for? What caution is given respecting wet clothing? What of sitting in a shade or current of air? What is the effect when the action of the sudoriferous glands is suppressed?

ble of disease than others. If a man is predisposed to stiffness of the joints, and rheumatic pains, a chill will operate upon these diseased parts. In a person whose lungs are weak or diseased, a chill will immediately cause an irritation, and often inflammation. The same is true of many other diseases.

PRACTICAL SUGGESTIONS.

To maintain a healthy action of the several tissues of the skin and the different sets of vessels found in them, attention to *clothing*, *bathing*, *light*, and *air*, is of practical importance.

CLOTHING.

The CLOTHING should be suited to the temperature of the climate and condition of the individual. *The rule should always be, to wear enough to maintain an equal and healthy action of the skin.* Care should be taken that the action of the cutaneous vessels is not inordinately increased, as this would debilitate, not only the skin, but the internal organs of the system, as the stomach and lungs. This is illustrated in night sweats and the sweats of hectic fever. The quantity of clothing demanded by different persons will vary, consequently no rule as to quantity will apply to all. The following are among the most prominent causes of this variation.

1. Those persons who have *large*, *active brains*, *full chests*, *well-developed lungs*, and *healthy stomachs*, and who take *food sufficient* to supply the wants of the system, will have more heat generated, and require less clothing, than those of an opposite character. The brain of the child at birth is immature, and endowed with a small amount of activity. The capacity of the stomach for food is small compared with that of an adult. There is, therefore, less heat generated in its system, and for this reason it needs the protection of more clothing. The ' experiments of Dr. Milne Edwards show that the power of producing heat in

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What is necessary to maintain a healthy action of the several tissues of the skin? What is the rule for the amount of clothing that should be worn? What is the effect if too much clothing is worn? Will the same amount of clothing suit every individual? What persons require the least quantity of clothing? Why? Why do children require more clothing than adults? What was proved by the experiments of Dr. Edwards?

warm-blooded animals is at its *minimum at birth, and increases successively to adult age*, and that young children, instead of being warmer than adults, are generally a degree or two colder, and part with their heat more readily.' The system of 'hardening' children, by an inadequate supply of clothing, and keeping them uncomfortably cold throughout the whole day, is inhuman, as well as unprofitable. It operates upon the child somewhat like the long continued chill upon a certain portion of the farmer's herd, that are kept shivering under the thatched shed, retarding the growth of their systems, requiring more food to satisfy the keen cravings of hunger and cold than when comfortably sheltered. To make the boy robust and active, give him nutritious food, at stated hours; let him exercise in the open air freely, guarding his system from chills by a due amount of apparel.

If the *brain, lungs*, or *digestive organs* are diseased, the generation of heat in the system is diminished. This is observed in headache, consumption, and dyspepsia, which are usually attended with a pale skin and cold extremities. Such persons, when exposed to cold air, need more clothing than those individuals whose organs are not diseased, and the functions of which are properly performed.

The person of active habits requires less clothing than one of sedentary employments; for exercise increases the circulation of the blood, which is always attended by the disengagement of a greater quantity of heat: consequently, an increase of warmth is felt throughout the system. We likewise need more clothing while riding, than when we are walking; because the exercise of the former is less than that of the latter. The same is true when resting in the field or shop, after laborious exercise; and, for the same reason, we need a greater amount of clothing while asleep than during the day; as not only the action of the body, but that of the brain during sleep, is suspended. The practical rule is, *when we cease exercise, or labor, increase the amount of clothing.*

2. The impressibility or sensitiveness of the skin to

What is said of the process of hardening children? Name other causes for the variation of heat. What is said of riding? Why do we need a greater amount of clothing while asleep than when awake? Does habit modify the sensitiveness of the skin?

the influence of cold, is much modified by *habit*. A person who has been habituated to the temperature of a warm room, or warm climate, suffers more when exposed to cold, than an individual who has been accustomed to colder air. Thus a person who labors or studies in a warm room, should wear more clothing when exposed to the air, while walking or riding, than an individual who labors in a cooler atmosphere. Not only is the impressibility of the skin increased by a warm atmosphere, but the activity of the digestive, respiratory, and nervous systems, in generating heat, is much diminished. This is an additional reason why an increased amount of clothing is demanded during exposure.

In all cases where practicable, the heat of the system should be maintained by *exercise*, in preference to the use of fur or flannel.

3. More clothing is required in the evening than during the day. In the evening the atmosphere is damp, and the skin has become moist from free perspiration. For these reasons we should be provided with an extra garment, to be worn when returning from crowded assemblies. The skin is then not only more moist by the dampness of the air in the crowded apartments, and by perspiration, but it is rendered more sensitive. If there be a chill upon the system after having arrived home, restore warmth as speedily as possible. This can be done by friction with warm flannels, and using the warm or vapor bath. By this procedure the pernicious effects of the chill will be prevented before any disease is fixed upon the system. Is it not the duty of the parent, the guardian, and the teacher, not only to learn these facts, but the reason why they should have a passing notice? Is it not incumbent upon the guardians of the young, to see that these rules are not only learned, but reduced to practice? The farmer and industrious mechanic would be freed from many a rheumatic pain, if, while resting from their labors at evening, or taking the ordinary meal after hard toil, they would put on an extra garment. The coat might not feel so agreeable for the first few minutes,

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What caution should we adopt under such circumstances? When do we need the most clothing? Why? In case of a chill, what should be done? Can all these principles be reduced to practice? Should they be?

but it would ultimately conduce to good feeling and continuance of health.

Different kinds of clothing will now be considered. The *articles of apparel should be such as will prevent the rapid abstraction of heat from the system.* This leads to an examination of the conducting properties of different articles of clothing. Silk and linen will conduct the heat from the system most rapidly; or, in other words, they permit its escape most rapidly. Woollen and furs are the poorest conductors of heat: consequently, they are best adapted to those who are exposed to the vicissitudes of heat and cold, as they keep up a general warmth of the system. Cotton is a medium article, and well adapted to the system, as an article of under clothing, as it is not a free conductor of heat.

2. The waste carried from the system is removed by the influence of the air, which shows the necessity of the apparel being loosely worn, and that its texture should be of a *porous* character. Health demands a free escape of the perspiration from the system: a suppression would cause disease. Hence, the prevalence of disease among fishermen, who wear India rubber garments. The same principle is illustrated in wearing rubber over-shoes. Let them be worn ten or twelve hours over boots, and not only the hose, but the boots will be moist, from retained perspiration, and the residual matter left in contact with the skin may be reconveyed into the system by the activity of the absorbents, causing headache and other diseases.

The cotton and woollen fabrics are not only non-conductors of heat, but are also porous: consequently, they are well adapted to transmit perspiration. An error prevails in the community in regard to the time of wearing flannels. Generally they are not worn till the last months of autumn, and taken off early in the spring. In the changeable climate of New England, flannels should be worn at least nine months in the year. Families who re-

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What should be the character of the clothing? What is the character of silk and linen, as articles of clothing? What of woollen and furs? Of cotton? How is the waste matter carried from the system? What does this show? How illustrated? What is said of cotton and woollen fabrics? How long should flannel be worn in New England? What should be the practice of those who visit marshy districts?

side in, and those who frequent marshy districts, where the air has floating in it poisonous animal and vegetable matter, should be clothed in flannel. The friction of flannel, when loosely worn, imparts a healthy stimulus to the cutaneous vessels.

Our next inquiry is relative to the change of clothing. Why should this be done? and how often? are inquiries of no slight importance. The insensible perspiration is composed of water, muriate of soda, or common salt, muriate of potash, an acid, a small amount of animal matter, some phosphate of lime, (an ingredient of the bones,) together with a very small trace of the oxide of iron, or common rust of iron. It is a well known fact, that the apparel of a person of sedentary habits becomes soiled, as well as the clothing of those who labor. This arises from the combination of the acid and salts, left in contact with the apparel. For an illustration—put into water some vinegar, common salt, a little animal matter, or oil, and the rust of iron, made into a fine powder; then dip a piece of white cloth into the solution, and after it is dried, it will be found soiled, from the salt, iron, and animal matter adhering to the threads; the water and vinegar having evaporated in drying. From this we learn the necessity of changing our garments when soiled, to prevent the residual matter from irritating the skin. When the pores of the cloth are coated with this waste material, it precludes the evaporation of the perspiration. This should not be forgotten in children, as their blood circulates with greater rapidity than that of adults, and this increases the amount of waste matter eliminated from their systems. Another reason for the frequent change of clothing is the feeling of comfort which it imparts. In cold weather, our garments, such as hose, are found to be warmer when clean, than after they have been worn several days.

Beds should not be made as soon as the occupant leaves them, but should be immediately thrown open to air, for perspiration is increased during the night, and the bed

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What effect has the friction of flannel? Of what is the insensible perspiration composed? Illustrate how insensible perspiration soils clothing. What do we learn from this? Is the amount of waste matter greater in children or in adults? Why? Why should beds not be made as soon as unoccupied?

clothes become imbued with it. Besides, if not properly ventilated, or aired, the bed is rendered damp, causing a chill, and the waste matter with which the bedding is more or less imbued, will be carried into the system of the next occupant, by the action of the absorbent vessels. Oftentimes diseases of a disagreeable nature are contracted in this way. This fact should be instilled into every mother's and every daughter's mind.

BATHING.

As only the watery portion of the perspiration is absorbed by the clothing, or escapes from the surface of the body by evaporation, if the residual salts, as soda, potash, and the rust of iron remain in contact with the skin, they operate as a species of varnish, in coating the pores of this tissue, and consequently, prevent the exit of the waste products from the system through the perspiratory ducts. This obstruction suppresses the action of the cutaneous arteries, and thus diminishes the heat of the skin; and the temperature of this tissue thus decreased, affects the system in general like a chill. To avoid this, and also to remove the residual salts, *bathing* and *friction* are required.

Let me here remark, that ablution should not be confined to the hands and face merely, as no portion of the skin is without pores. It would seem, should we judge of children sometimes seen in the streets, that but a small part of their systems was washed daily. Fifteen minutes spent each day in washing the surface of the skin, and rubbing it with a rough, crash towel, would amply compensate for the time spent, in the agreeable sensations it produces.

When the skin is cleanly, it will resist the chilling influence of cold longer than when an opposite condition exists, for the reason that the cutaneous circulation is more vigorous. The danger of freezing the extremities is greater, when the feet and hands are unclean and covered with unclean clothing; and the same is true of other parts of the system.

Are diseases ever contracted by occupying beds that have not been ventilated? What are the reasons for bathing frequently? Why should the whole system be bathed? When will the skin resist the influence of cold the longest?

Various methods of bathing are practised in the community. It may be *partial* or *general.* Water may be used *cold, tepid* or *warm.* A person may apply it to his system with a sponge, or immerse himself in it. In this as in other labor, the more simple the manner, the more general the application.

In all instances, *cold* water is preferable when reaction can be induced, indicated by warmth and redness of the skin after the application of friction. But if there be a continued chilly sensation, substitute the tepid bath. In using cold water, it should be applied quickly, followed by active friction, and continued but a short time.

It may be well for feeble persons to use the tepid or lukewarm bath, applying it to the system, and rubbing the limbs and trunk smartly, until there is a healthy glow of the skin, and then continue the accustomed exercise. In using the *warm* or *vapor* bath, it should be only moderately heated at first, and the temperature gradually increased the longer the individual remains in it. But it is not advisable to remain long in a warm or vapor bath, if you wish an invigoration of the system. The same directions should be observed in using the foot-bath, or soaking the feet in warm water. The foot-bath, when long continued, has an injurious effect upon the system, whereas, if continued but a short time, it may be highly beneficial. In all kinds of bathing, care should be taken that the skin be wiped dry and rubbed thoroughly, as not only the residual matter is removed, but also the useless, thickened scarf-skin, which is often seen in rolls upon applying friction with warm water.

A vapor apparatus should be in every family, and it can be used with little trouble. The timely use of the bath, whether simple or medicated, would not unfrequently prevent fevers and other diseases. As bathing the whole system is much neglected by Americans, let mothers early inculcate the necessity of ablution, and thus form habits in childhood, that will not be eradicated in after years. No person's system can be healthy, un-

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When should *cold* water be used in bathing? What directions are given in using cold water? What in using the *warm* or vapor bath? What caution is given in taking a warm or vapor bath? How may a warm foot bath be injurious to the system?

less the skin is soft and pliant. When this membrane is dry and scaly, the scales can be removed, and the skin made soft, by bathing and friction. Water, with little or no soap, is best suited to the nature of the skin; as the alkali, which is contained in the soap, unites with the oil of the skin, and removes it. This gives the skin a sodden, or shrivelled appearance, like the hand of the washerwoman.

In bathing, the state of the system should be regarded: 1st. The skin should not be cold, and its vessels inactive, when the bath is taken; because a healthy and vigorous reaction will follow more rapidly, and with more certainty, when the action of the cutaneous vessels is energetic. 2d. Bathing should not be performed when the system is exhausted by muscular or mental exertion, as this condition does not favor a reaction of the cutaneous vessels. 3d. A bath should not be taken immediately before or after a full meal, for, during the first hour or two after eating, the skin is pale, and the vigor of its circulation diminished. But bathing should be practised when the skin is warm, and its circulation vigorous; when the system is not exhausted by mental or physical labor, and about two hours after a moderate meal has been taken. Gentle exercise after bathing would be beneficial, to increase the vigor of the cutaneous circulation. If the system of bathing were introduced and practised by every member of the community, headaches, cold extremities, coughs, and diseases of the lungs, stomach, and intestines, would be greatly diminished.

AIR.

As the waste material which is carried from the system in the form of perspiration, is removed from the skin by being diffused through the atmosphere, it is of much importance that the surrounding air be pure. In the sultry mornings of July and August, the air is loaded with moisture and impurities, and the perspirable matter is not removed from the system, as it is when the air is pure

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Should soap be used in large quantities in bathing? Why not? What appearance does it give to the skin? What is the first condition to be regarded in bathing? Second? Third? When should we bathe? What is said of exercise after bathing? Of the introduction of the practice of bathing into the community?

and dry. This is the cause of the general lassitude, that is experienced during such mornings. As soon as the fog is dispelled these unpleasant sensations are removed.

To sustain the functions of the skin in a healthy state, the parlor, kitchen, sleeping room, school-house, and workshop, should be well ventilated. The blood of the system will be purer, and its color of a brighter scarlet, if the skin be kept clean by ablution, warm by proper clothing, and surrounded by air fresh and pure.

LIGHT.

It is observed by all that solar light exercises much influence upon the vigor and color of vegetables. Plants that are kept in well-lighted rooms have darker and more brilliant colors than those that grow in darkened apartments. Light exercises a similar influence on men and animals. Thus we see that those individuals who labor in low, damp, dark rooms, are pale and sickly. By the light permeating the skin, it not only exercises a salutary influence upon this tissue, but upon the blood, and, through this fluid, upon the whole system. This established fact shows how important it is that school-houses, and mechanics' shops, kitchens, and sitting-rooms, be not only well ventilated, but favorably situated to receive light. For the same reasons, the *kitchen*, and the *sitting-room*, which are the apartments most used by ladies, should be selected from the most *pleasant* and *well-lighted* rooms in the house. Dark rooms and damp cellar-kitchens should be avoided, as exercising an injurious influence upon both body and mind. The dark, damp rooms, so much used in cities and large villages, by indigent families and domestics, are fruitful causes of disease, vice, poverty, and suffering.

APPENDAGES TO THE SKIN.

The HAIRS are appendages to the skin. They have no blood vessels or nerves, and consequently no vitality. They are a product of secretion. The hair takes its ori-

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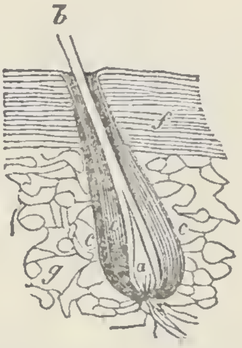
What is the cause of the lassitude we feel during the sultry weather? What is necessary to sustain the functions of the skin in a healthy state? What is said of the effect of *light*? What does want of light effect? To what does this point? What are the *hairs*? Describe them.

gin from the cellular membrane, in form of *bulbs.* In texture, it is dense, and homogeneous towards the circumference, and porous and cellular in the centre, like the pith of a plant. Every hair has on its surface pointed barbs, arranged in a spiral manner, and directed towards the root of the hair; so that if a hair is rolled between the fingers, it moves only in one direction. The color of the hair varies in different individuals, and is generally supposed to depend on the fluids contained in the pith. In several instances, it has been known to change from black to gray in the course of a single night, from the effect of grief, or some other great mental agitation.

There are two causes which act in changing the hair gray. The first is, defective secretion of the coloring fluid. The second is, the canals, which convey the fluid into the hair, become obliterated. In the first instance, the hair remains; in the second, it dies and drops out. Each hair is enclosed beneath the surface by a vascular, secretory follicle, which regulates its form during growth. This is represented in the following engraving.

Fig. 7.



In fig. 7, the hair follicle, *e*, represented as embedded in the cellular membrane *g*, which is situated beneath the skin; *c*, *c*, the membranous sac, which has a narrow neck, opening externally by a contracted orifice, through which the hair, *b*, passes. Its internal surface, *e*, is smooth, and not adherent to the hair, but separated from it by a reddish fluid. From the bottom of the sac at *a*, the pulp of the hair arises. The hair passes through the skin at *f*.

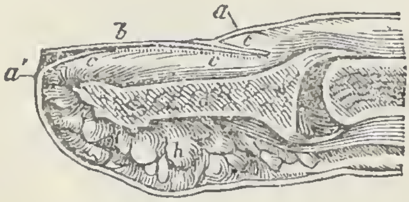
The NAILS are hard, elastic, flexible, semi-transparent scales, and present the appearance of a lamina of horn. The nail is divided into the *root*, the *body*, and the *free*

Upon what does the color of the hair depend? What are the causes of hair becoming gray? What is the cause of the hair dropping out? How is each hair enclosed beneath the surface of the skin? Describe fig. 7. Describe the *nails.*

portion. The root is that part which is covered on both surfaces; the body is that portion which has one surface free; the free portion projects beyond the end of the finger.

The nail is formed of several laminæ, that are fitted the one to the other; the deepest is that which is last formed. The nails, like the hoofs of animals, and the cuticle, are products of secretion. They receive no blood vessels or nerves. If the cuticle be removed in severe scalds, they will separate with it, as the hoofs of animals are removed by the agency of hot water. The nails increase in length and thickness, by the deposition of albumen upon their under surface, and at their roots.

Fig. 8.



This engraving represents a section of the end of the finger and nail. *d*, Section of the last bone of the finger; *h*, fat forming the cushion at the end of the finger; *b*, the nail; *a*, *a*, the cuticle that is continued under and around the root of the nail at *c*, *c*, *c*.

The SEBACEOUS FOLLICLES are small pouches, or bags, about the size of millet seeds. They lie within the true skin, and open externally by very small orifices, which are visible under a magnifying glass, and in some individuals, even to the naked eye. From these orifices an unctuous matter is poured out upon the surface of the skin. Sometimes the matter secreted by these glands assumes a dark appearance, in the form of black specks, which are called, by many, *worms*, because, when expressed, they assume that aspect.

The PERSPIRATORY DUCTS are minute, spiral tubes, which commence in the lobulated sweat glands, situated beneath the fat vesicles, under the skin, and terminate upon the surface of the cuticle. *See fig.* 6.

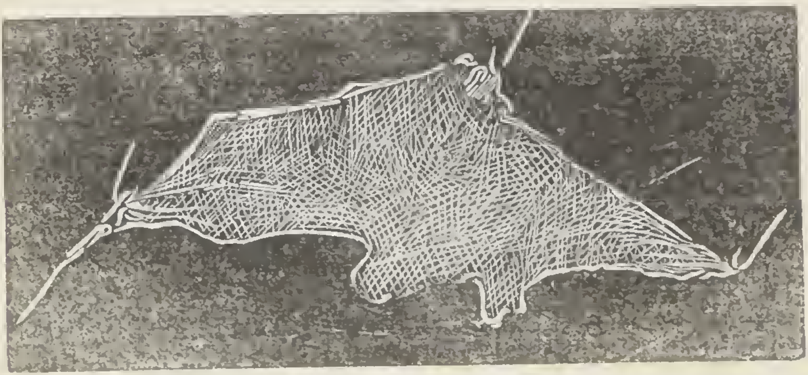
How are the nails formed? If the cuticle be removed by scalds, are the nails likewise separated? Describe fig. 8. What are the *sebaceous* follicles? What is their use? What are the *perspiratory* ducts?

CELLULAR TISSUE.

This membrane, considered by some anatomists as the primary tissue, is formed of innumerable small fibres, of every variety of shape and size, running in every possible direction, forming a reticulated or net-like arrangement. In some situations these fibres are narrow, loose, and comparatively distant. In others, they are broad and close, so as to form partial cells, which communicate with each other. To prevent the cells of this net-work from adhering, a fluid, formed from the blood vessels or the membrane itself, is secreted or thrown out, which keeps them always moist. When this fluid becomes too great in quantity, in consequence of disease, the patient labors under general dropsy. The swelling of the feet when standing, and their return to a proper shape during the night, so often noticed in feeble persons, furnishes a striking proof both of the existence and peculiarity of this membrane, which allows the fluid to flow from cell to cell, until it settles in the lowest part.

One remarkable circumstance connected with this tissue is, that it exists throughout the body, and is every where accessible to air. This is shown by forcing air into its cells in any part of the system. It will permeate and penetrate every part until the whole body is inflated. Butchers often avail themselves of a knowledge of this fact, and inflate their meat to give it a fat appearance.

Fig. 9.



This figure represents a single film of cellular membrane raised and slightly distended.

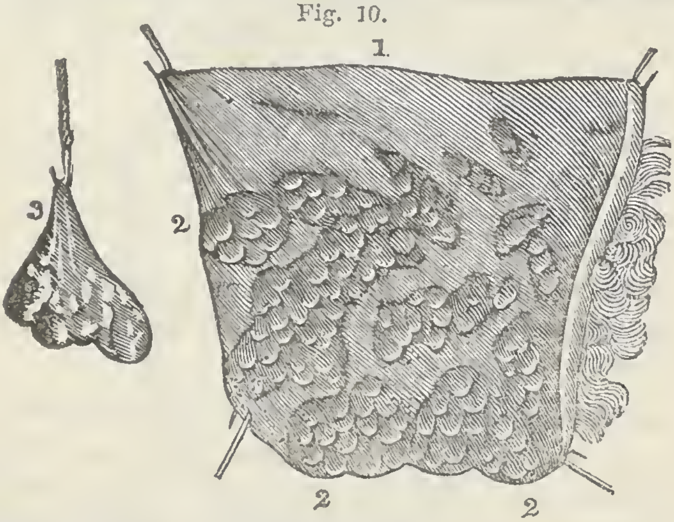
What is the *cellular tissue* considered to be, by some anatomists? Describe it. What striking proof of the existence and peculiarity of this membrane? What remarkable circumstance is connected with this membrane? How is this shown? What use do butchers make of a knowledge of this tissue?

Although this tissue enters into the composition of all organs, it never loses its own structure, nor participates in the functions of the organ of which it forms a part. Though present in the nerves, it does not share in their sensibility; and though it accompanies every muscle and every muscular fibre, it does not partake of the irritability which belongs to those organs.

ADIPOSE TISSUE.

This substance, commonly called *fat*, is deposited in distinct bags, that are seen in the loose cellular membrane. Fig. 10 gives a representation of the adipose tissue.

Fig. 10.



1. A portion of the adipose membrane. 2. Minute bags containing fat. 3. A cluster of these bags, separated and suspended.

In those individuals who are corpulent, there is, in many instances, a great deposit of this substance. As this accumulates more readily than other tissues when a person becomes gross, so it is earliest removed when the system emaciates, in acute or chronic disease. In some instances, some of the masses, called *pelitongs*, which compose this tissue, become enlarged. These enlargements are called *adipose tumors*.

Adipose tissue is, principally found beneath the skin, abdominal muscles, and around the heart and kidneys; while none is found in the cranium, brain, eye, ear, nose, and several other organs.

Has it sensibility? Describe the *adipose tissue.* What does fig. 10 represent? Does the adipose tissue accumulate readily? Do these masses ever enlarge? What are they called? Where is the adipose tissue mostly found? Where is it never found?

CHAPTER III.

ANATOMY OF THE BONES.

In the mechanism of man, the variety of movements he is called to perform requires a correspondent variety of component parts, and the different bones of the system are so admirably fitted to each other, that they admit of this extent of motion.

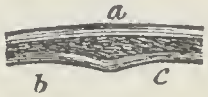
When the bones composing the skeleton are united by natural ligaments, they form what is called a *natural skeleton:* when united by wires, what is termed an *artificial skeleton.*

The protuberances of the bones are termed *processes;* and are, generally, the points of attachment for muscles and ligaments.

ANATOMY OF THE BONES OF THE HEAD.

The head is divided into *cranium* and *face.* The bones of the cranium are eight in number. They are formed of two laminæ, or tablets of bony matter, united by a spongy or porous portion of bone.

Fig. 11.



a, The external bone; *b*, *c*, the internal table. The intervening cellular texture is spongy, and conveys vessels and nerves from one part to another.

The external lamina is fibrous and tough: the internal plate is dense and hard, and is called the *vitreous,* or *glassy table.* These tough, hard laminæ are calculated to resist the penetration of sharp instruments, while the different degrees of density possessed by the two tablets,

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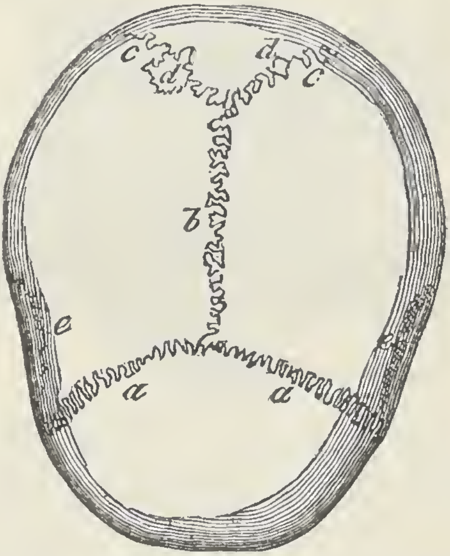
Is there an adaptation of the bones of the system to the office they are required to perform? What is a natural skeleton? What an artificial? Of what use are the processes? How are the bones of the *head* divided? How are the bones of the cranium formed? Describe the external tablet. The internal.

and the intervening spongy bone, are calculated to diminish the vibrations that would occur in falls or blows.

All the bones of the cranium are united by ragged edges, called *sutures*, from *suo*, I stitch. When one seam overlaps the other, it is called a *false suture*. All true sutures are zigzag lines, (*as seen in figure* 12.)

The sutures interrupt, in a measure, the vibrations produced by external blows, and also prevent fractures from extending as far as they otherwise would, in one continued bone.

Fig. 12.



a, *a*, The coronal suture; *b*, the sagittal suture; *c*, *c*, the lambdoidal suture; *d*, *d*, the *ossa triquetra*, small ragged bones, occasionally found in some skulls, lying in the last-mentioned suture; *e*, *e*, partitions of the temporal bone.

From infancy to the tenth or twelfth year, the sutures are imperfect; but, from that time to thirty-five or forty, they are distinctly marked; in old age, they are nearly obliterated.

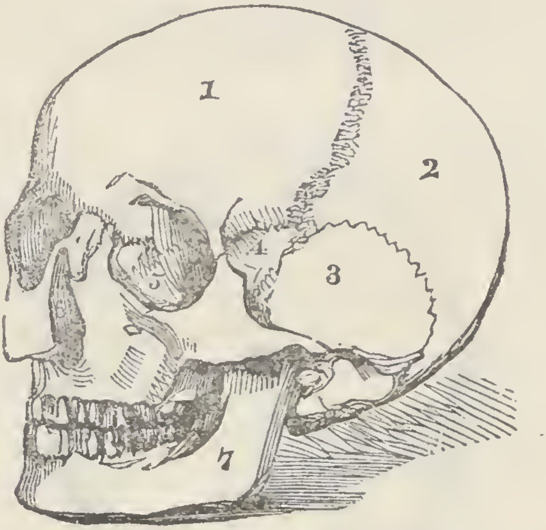
Blows should by no means be given children on the head, either with the hand or by sticks, as the entire character and destiny of a child may be altered by a blow on the half-formed skull.

The skull is convex externally, and at the bottom much

How are the bones of the cranium united? What kind of lines have true sutures? What are the uses of the sutures? What is said of the *ossa triquetra*? What of the changes of the sutures? Should *blows* be given on the head? What is the form of the skull?

thicker than at the top or sides. The most important part of the brain is placed here, completely out of the way of injury, unless of a very serious nature. The bottom of the cranium has many projections, depressions, and holes; the latter affording passage for the nerves and blood vessels.

Fig. 13.



This engraving will convey a general idea of the form of the bony skull, and of the manner in which the bones are connected. 1. The bone of the forehead called the frontal. 2. The parietal bone upon the side of the head. 3. The temporal bone. 4. The wedge-shaped bone, which forms the key-stone of the arch of the cranium. 5. The cavity for the protection of the eyes. 6. The holes which aid in the formation of the nostrils. 7. The lower jaw.

We find as great a diversity in the form and texture of the skull bones, as in the expression of the face. The head of the New Hollander is small; the African has a compressed skull; while the Caucasian is distinguished by the beautiful, oval form of the head. The Greek skulls, in texture, are close and fine, while the Swiss are softer and more open.

In the face are fourteen bones, some of which serve for the attachment of powerful muscles, which are more or less concerned in masticating food; others retain in place the soft parts of the face.

The teeth are inserted in the alveoli of the upper and lower jaw. Generally each tooth is divided into two

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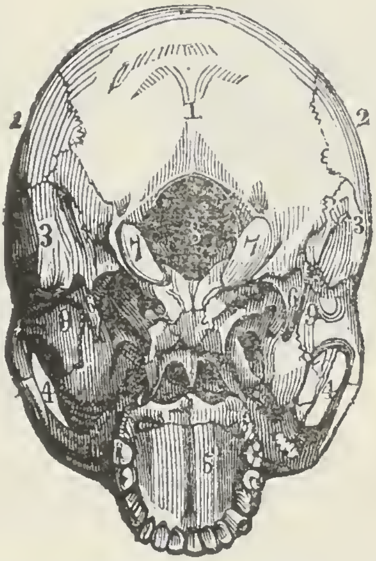
How does the base of the skull compare in thickness with the top and sides? Is there, in different nations, a diversity as to the form and texture of skull bones? Give some instances. How many bones in the face? Their use? Into what parts is a tooth divided?

parts; one situated without, and called the *crown;* the other buried in the alveolus, and terminated by one or more points, is called the *root* of the tooth. Between the crown and the root, a slight shrinking is often remarked; this is called the neck of the tooth.

Fig. 14.



This view will display to the pupil the more important points of the base of the skull. 1. The occipital bone. 2, 2. The parietal bone. 3, 3. The temporal. 4, 4. A hole formed by the union of a projection from the temporal bone, with a projection from the upper jaw. 5. The bony plate which forms the roof of the mouth. 6. Small pyramidal projections from the temporal bones. 7, 7. The condyles that unite the skull and spine. 8. Spinal hole, through which the spinal cord passes. 9, 9. The depression into which the lower jaw fits.

The teeth are the only bones in the human frame which are exposed to the immediate action of foreign bodies. To prevent them from being corroded, they are covered with *enamel*, from which they derive security as well as beauty.

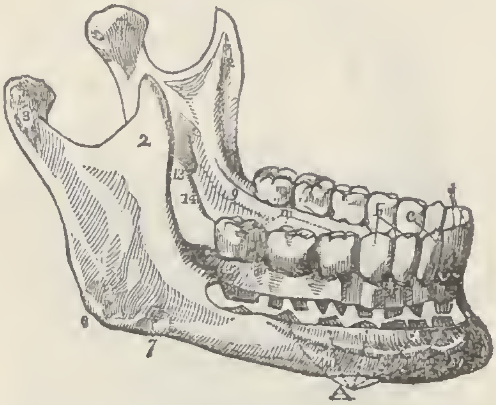
The teeth are formed in the interior of the jaws, and within little membranous pouches, called *dental capsules*, which are inclosed within the substance of the bone, and present in their interior a fleshy *bud*, or granule, from the surface of which exudes the stony matter, called ivory, of which the tooth is composed.

In proportion as the tooth is formed, it rises in the

Describe fig. 14. What prevents the teeth from being corroded? How are teeth formed? When does the tooth rise in the alveolus?

alveolus, passes through the gum, and shows itself without. The enamel is formed at the superior portion of the dental capsule, and covers the tooth just to the extent it traverses that part of the capsule; for this reason the root, which remains in the alveolus, is not covered by enamel.

Fig. 15.



1. The body of the lower jaw. 2. Ramus, to which the muscles which move the jaw are attached. 3. The condyle which unites the jaw with the head. *i*, The middle and lateral incisor tooth of one side; *b*, the two bicuspid teeth; *c*, the cuspides, or eye teeth; *m*, the three molar teeth. A shows the relation of the permanent, to the deciduous or temporary teeth.

The teeth which are formed in the earliest period of life, are called *temporary*, or *milk teeth.* They number twenty. The *permanent* teeth are more solidly fixed in the jaw, and number thirty-two; *eight incisors,* because they serve to cut the food; *four cuspid,* or *canine teeth,* two of which, in the upper jaw, are called *eye teeth; eight bicuspids,* so called because they terminate in *two points; eight molars,* or *grinders; four wisdom teeth,* so called because they do not usually appear until the individual has arrived at mature age.

The *temporary* teeth in children should be removed as soon as they become loose, for the reason that the *permanent* teeth are forming in alveoli of the jaw, (*Fig.* 15, *at* A.) and, if their egress is impeded, they will present in manhood a crowded or irregular appearance.

Where is the enamel formed? Why is there no enamel on the roots of teeth? What are those teeth called that are formed in infancy? Their number? Those in childhood? Their number, and how divided? Why should attention be given to the removal of the milk or temporary teeth? Describe fig. 15.

In the tongue there is one bone, named the *os hyoides*. It is shaped like the letter *u*, is situated at the under and back part of the lower jaw, and above the prominence of the throat.

Fig. 16.

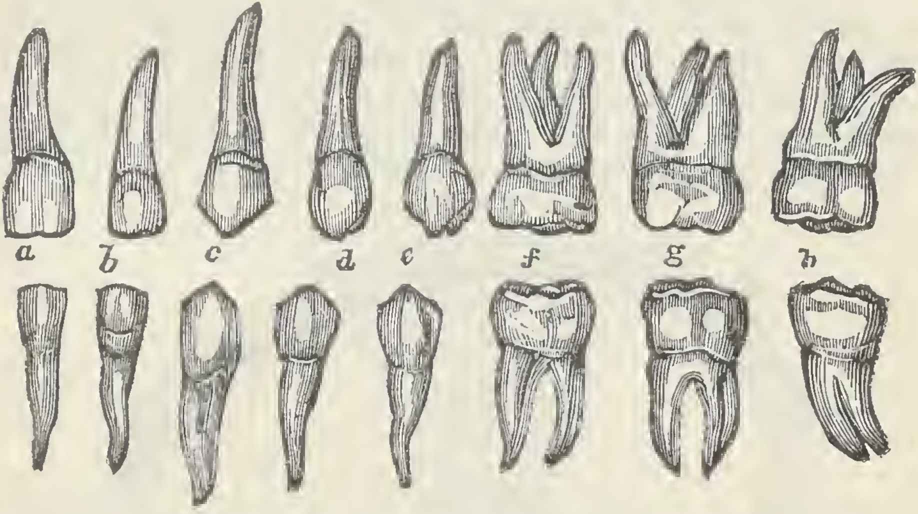
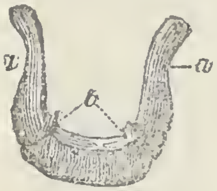


Fig. 16. The permanent teeth; *a*, central incisor; *b*, lateral incisor; *c*, cuspid, or canine; *d*, first bicuspid; *e*, second bicuspid; *f*, first molar; *g*, second molar; *h*, third molar, or *dens sapientiæ*.

Fig. 17.



a, *a*, are the great cornua; *b*, the small cornua.

BONES OF THE TRUNK.

The TRUNK contains fifty-four bones. They are so arranged as to form, with the soft parts attached to them, two cavities, named the *thorax*, or *chest*, and the *abdomen*.

The THORAX is composed of twelve *vertebræ*, twenty-four *ribs*, and the *sternum*.

The RIBS are twenty-four in number; twelve on each side. The seven upper ones are united to the sternum, through the medium of cartilages, and are called the *true*

What is the name of the bone of the tongue? Where is it situated? How many bones in the *trunk*? What do they form? Describe the *thorax*, or chest. How many *ribs* are there? How are the seven upper ribs united?

ribs. The cartilages of the five lower ribs are united with each other, and are not attached to the sternum; these are called *false ribs;* the lowest two are called floating ribs. All the ribs are connected with the spinal column, and increase in length as far as the seventh. From this, they successively become shorter. The direction of the ribs from above downward, is oblique, and their curve diminishes from the first to the twelfth. The inferior, or lower ribs, are very flat. The external surface of each rib is convex; the internal, concave.

Fig. 18.

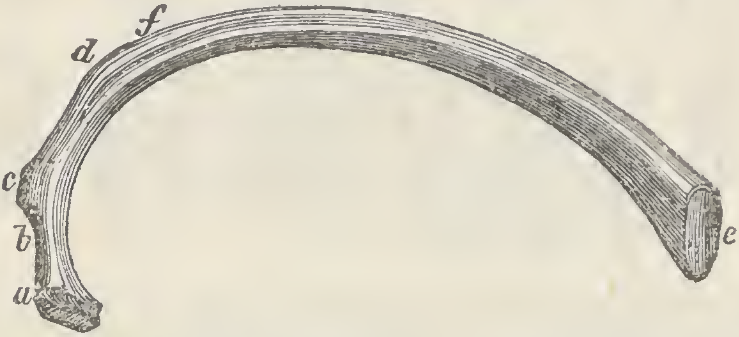


Fig. 18 is a representation of the fourth rib; *a*, vertebrated extremity, called the dorsal, which is connected with two of the vertebræ; at *b*, the bone is contracted, forming the neck; *c*, the tubercle at the back of the rib, which is articulated with the transverse process of the vertebræ; *d*, the angle; *e*, the sternal extremity; *f*, a groove for the internal vessels.

The STERNUM, sometimes called the breast bone, is composed of eight pieces in the child. These unite and form but three parts in the adult. In youth the two upper portions are converted into bone, while the lower portion remains cartilaginous and flexible until extreme old age.

The THORAX is formed of the sternum in front; the ribs at the sides; and the spinal column posteriorly. The natural form of the chest is a cone, with its apex above, but fashion, in many instances, has nearly inverted this order. This cavity contains the lungs, heart, and large blood vessels.

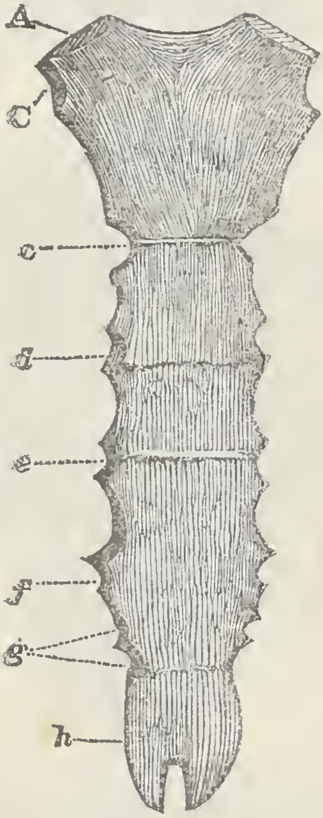
The SPINE contains twenty-four bones, or vertebræ: on examining one of the bones, we find seven projections, named *processes;* four of these, that are employed in

---

The five lower ribs? How do they increase in length? How many pieces is the *sternum* composed of in infancy? In adults? What changes in these portions? What is the form of the chest? What does this cavity contain? How many bones in the *spine*? What is another name for these bones? How many processes have they?

binding the bones together, are called articulating; two of the remaining, are called the transverse, and the other, the spinous. The latter gives attachment to the muscles of the back. The large part of the vertebra, called the body, is round and spongy in its texture, like the extremity of the round bones. The processes are of a more dense character. The projections are so arranged that a tube or canal is formed immediately behind the bodies of the vertebræ, in which is placed the *medulla spinalis*, or spinal cord, sometimes called the pith of the back bone.

Fig. 19.



A, The point where the clavicle is united to the sternum; C, *c*, *d*, *e*, *f*, *g*, the articulation of the seven superior ribs with the sternum; *h*, the ensiform cartilage; *c* and *g*, the division of the sternum into three parts.

Between these joints or vertebræ, is a peculiar and highly elastic substance, which much facilitates the bending movements of the back. This yielding cushion of cartilage also serves the important purpose of diffusing

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Which process gives attachment to the muscles of the back? Where is the spinal cord situated? What is placed between each vertebræ? What is its use?

and diminishing the shock in walking, or leaping, and tends to protect the delicate texture of the brain.

Another provision for the protection of the brain which bears convincing proof of the transcendent wisdom and beneficence of the Creator, is the antero posterior, or forward and backward curve of the spine. Were it a straight column, standing perpendicularly, the slightest jar would cause it to recoil with a sudden jerk, like a straight, steel spring, passed between the hands from its extremities. In such a case, the weight bearing equally, the spine would neither yield to the one side or the other. But, shaped as it is, we find it yielding in the direction of the curve.

Fig. 20.

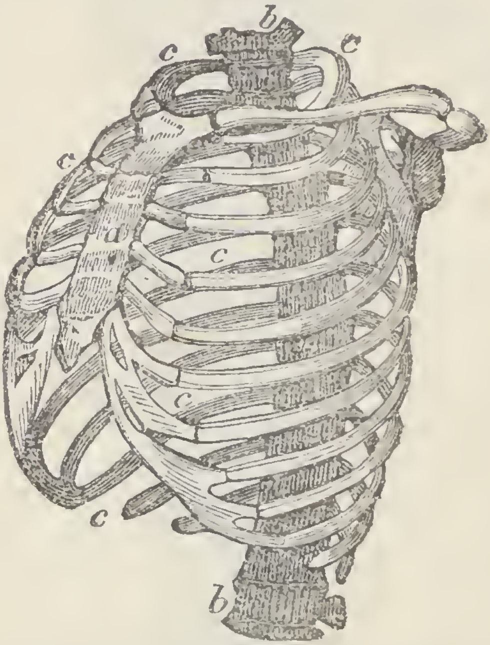


Fig. 20 represents the entire frame of the chest, of the natural form, and the several bones in their proper positions. *b*, *b*, The spine; *a*, sternum, or breast bone; *c*, *c*, *c*, *c*, *c*, *c*, designate the ribs, the upper ones being more curved and much shorter than the lower ones. The parts between the division of the ribs and the sternum, represent the cartilages that join the ribs with the breast bone.

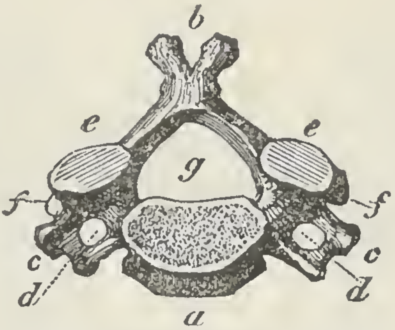
The PELVIS is composed of four bones; the *sacrum*, the two *innominata*, and the *coccyx*.

The INNOMINATUM, or nameless bone, in the child, con-

What is another provision for the protection of the brain? What would be the effect were the spine a straight column? What does fig. 20 represent? Of how many bones is the *pelvis* composed? What will you say of the *innominatum*, in the child?

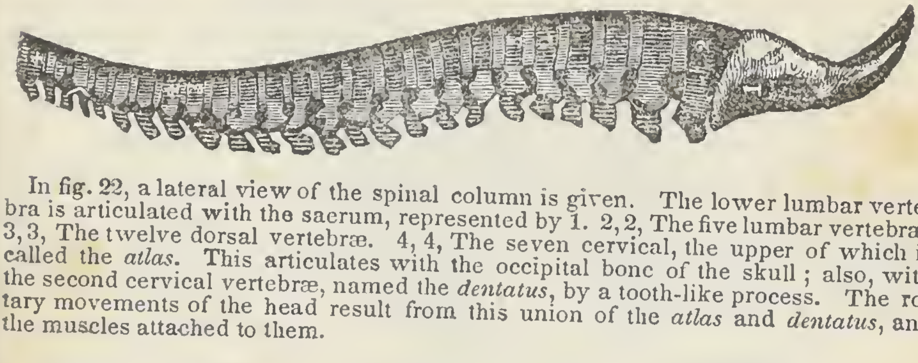
sists of three pieces. These, in the adult, become united, and constitute but one bone. In the sides of these bones is a deep depression, like a cup, called the *acetabulum*, in which the head of the thigh bone is placed.

Fig. 21.



'This is an accurate drawing of one of the bones of the spine at the neck; *a*, is the body of the bone; *b*, the spinous process, or handle, which gave the name of the spine to the whole column; *c*, *c*, the transverse processes to which the muscles adhere, producing motion; *d*, *d*, round holes through the arms of the bones, for safely lodging an artery which carries blood to the brain; *e*, *e*, the upper, *f*, *f*, the under surfaces, which make a joint above and below it; *g*, the hole through which the spinal cord passes in safety from the head, through the whole chain of twenty-four vertebræ.'

Fig. 22.



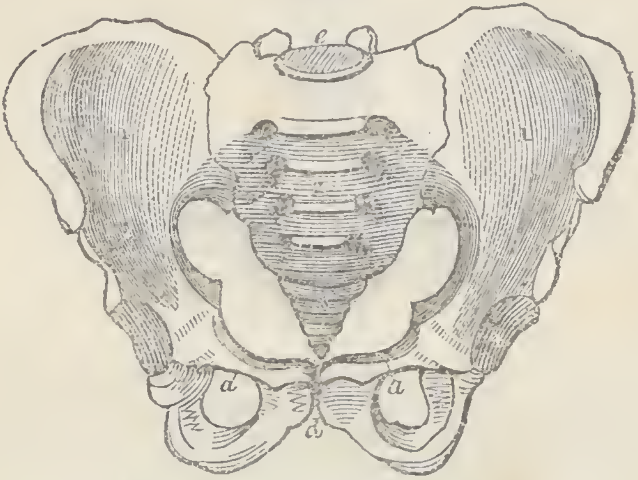
In fig. 22, a lateral view of the spinal column is given. The lower lumbar vertebra is articulated with the sacrum, represented by 1. 2, 2, The five lumbar vertebræ. 3, 3, The twelve dorsal vertebræ. 4, 4, The seven cervical, the upper of which is called the *atlas*. This articulates with the occipital bone of the skull; also, with the second cervical vertebræ, named the *dentatus*, by a tooth-like process. The rotary movements of the head result from this union of the *atlas* and *dentatus*, and the muscles attached to them.

The SACRUM, so called because the ancients offered it in sacrifices, is a wedge-shaped bone, that is placed between the innominata, and to which it is bound by ligaments. Upon its upper surface it connects with the lower vertebra. At its inferior or lower angle, it is united to the coccyx. It is concave upon its anterior, and convex upon its posterior surface.

What is said of the *innominatum*, in the adult? What is the depression in the side of this bone called? What is its use? What is the upper cervical vertebra called? With what does this articulate? How is the rotary movement of the head effected? Describe the *sacrum*.

The coccyx, in infants, consists of several pieces, which, in youth, become consolidated into one bone. This is the terminal extremity of the spinal column. These bones form the walls of a cavity named the *pelvis.*

Fig. 23.

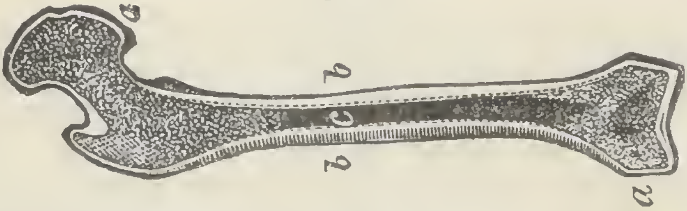


1, 1, Innominata. 2, Sacrum. 3. Coccyx. 4, 4, Acetabulum. *a*, *a*, pubic portion of the innominata; *d*, arch of the pubes; *e*, junction of the sacrum and lower lumbar vertebra.

BONES OF THE EXTREMITIES.

The bones of the upper and lower limbs are enlarged at each extremity, and have projections that are called processes. To these the tendons of muscles and ligaments are attached, which connect one bone to another. The shaft of these bones is cylindrical and hollow. In structure their exterior surface is hard and compact, while the interior portion is of a reticulated character. The enlarged extremities of the round bones are more porous than the main shaft.

Fig. 24.



The above engraving represents a section of the thigh bone; *a*, *a*, the extremities, having a shell, or thin plate of compact texture, covering small cells, diminishing in size, but increasing in number, as they approach the articulation: *c*, the cavity that contains the marrow; *b*, *b*, the walls of the shaft, which are very firm and solid.

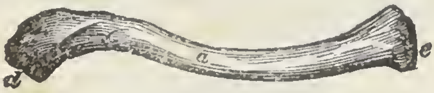
Describe the *coccyx*. Describe the bones of the upper and lower extremities. What is said of their structure? What does Fig. 24 represent?

BONES OF THE UPPER EXTREMITIES.

The upper extremities contain the *clavicle*, or collar bone, the *scapula*, or shoulder bone, the *humerus*, or first bone of the arm, the *two bones* of the *fore-arm*, *eight bones* in the *wrist*, *five* in the *hand*, *fourteen* in the *fingers* and *thumb*—making sixty-four in both arms and hands.

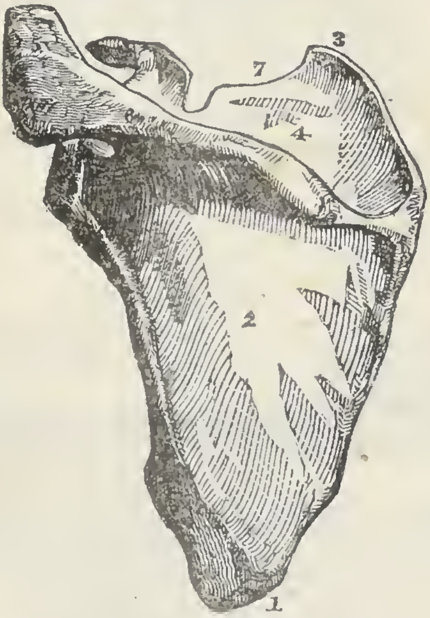
The CLAVICLE is attached, at one extremity, to the *sternum;* at the other, it is united to the *scapula*. It is shaped like the italic *f*. Its use is to keep the arms from sliding towards the breast. This bone can be lengthened by throwing the arms back, consequently enlarging the chest. The French have longer clavicles and broader chests than the Americans, though their stature is smaller. This is the result of their early physical education.

Fig. 25.



a, Body of the clavicle; *e*, extremity that articulates with the sternum; *d*, the point where it articulates with the scapula.

Fig. 26.



1, Is the inferior angle of the scapula. 2, Body of the bone. 3, Superior angle. 4, Glenoid cavity, upon which the head of the scapula is placed. 5, Acromion process, to which the cavicle is articulated. 6, Spine of scapula.

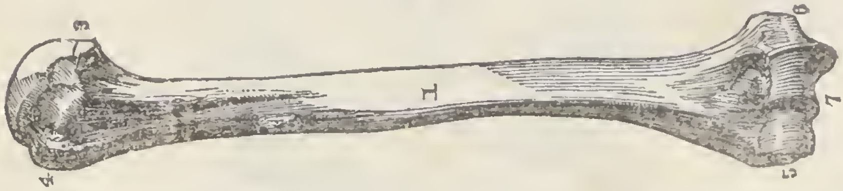
Name the bones of the upper extremities. How many in number? Where is the *clavicle* attached? Its form? Its use? How do the collar bones of the French compare in length with the Americans?

The SCAPULA, or shoulder bone, is situated upon the upper and back part of the chest. It is flat, thin, and of a triangular form.

This bone lies upon, and is retained in its position by muscles. By their contractions it may be moved in different directions.

The HUMERUS is cylindrical, and forms at the elbow a hinge-like joint, by its junction with the ulna of the fore-arm; at the scapular extremity it is lodged in the glenoid cavity, where it is surrounded by a membranous bag, called the capsular ligament.

Fig. 27.



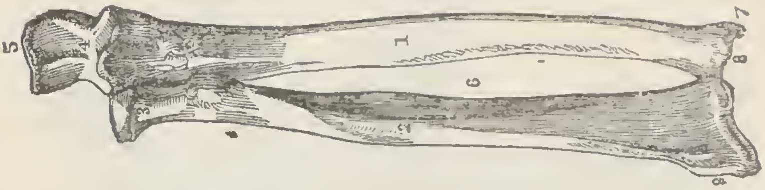
1, The shaft of the humerus. 2, The large, round head that is placed in the glenoid cavity, forming the shoulder joint. 3 and 4, tuberosities, to which muscles are attached. 5, condyle, forming the external elbow. 6, internal condyle, forming the internal elbow. 7, articulating surface upon which the ulna rolls.

The FORE-ARM contains two bones, named the *radius* and *ulna*.

The ULNA is articulated with the humerus at the elbow, forming a perfect hinge joint.

The RADIUS is articulated with the bones of the carpus, to form the wrist joint. The two bones, at each extremity, articulate with each other, by which union the rotary movement of the hand is permitted.

Fig. 28.



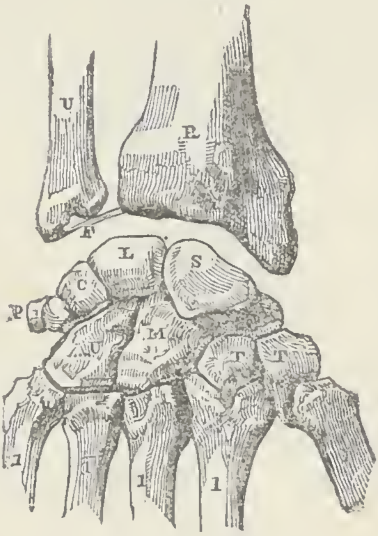
1, The body of the ulna. 2. The shaft of the radius. 3. The upper articulation of the radius and ulna. 4. Articulating cavity, in which the lower extremity of the humerus is placed. 5, Upper extremity of the ulna, called the olecranon process, which forms the point of the elbow. 6. Space between the radius and ulna, filled by the intervening ligament. 7, Styloid process of the ulna. 8. Surface of the radius and the ulna, where they articulate with the bones of the wrist. 9. Styloid process of the radius.

Where is the shoulder bone situated? How is it retained in its place? How is it moved? Describe the *humerus*. How is it attached at the scapular extremity? Describe Fig. 27. What are the two bones of the fore-arm called? How is the rotary motion of the hand effected?

The CARPUS, or wrist, is composed of eight bones, ranged in two rows, and so firmly bound together as to permit only a small amount of movement.

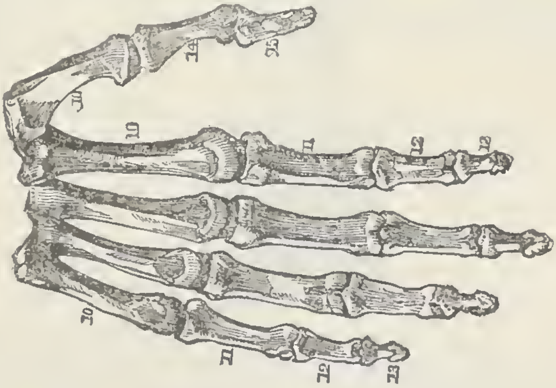
The METACARPUS, or palm of the hand, is composed of five bones, upon four of which, the first range of the finger-bones is placed; and upon the other, the first bone of the thumb is placed. The five metacarpal bones articulate with the second range of carpal bones.

Fig. 29.



U, The ulna; R, the radius; S, the scaphoid bone; L, the semilunar bone; C, cuniform bone; P, pisiform bone. These four form the first row. T, T, trapezium and trapezoid bones; M, the os magnum; U, the unciform bone. These four form the second row. 1, 1, 1, 1, 1, The metacarpal bones of the thumb and fingers.

Fig. 30.



10, 10, 10, The metacarpal bones of the hand. 11, 11, First range of finger bones. 12, 12, Second range of finger bones. 13, 13, Third range of finger bones. 14 and 15, First and second bones of the thumb.

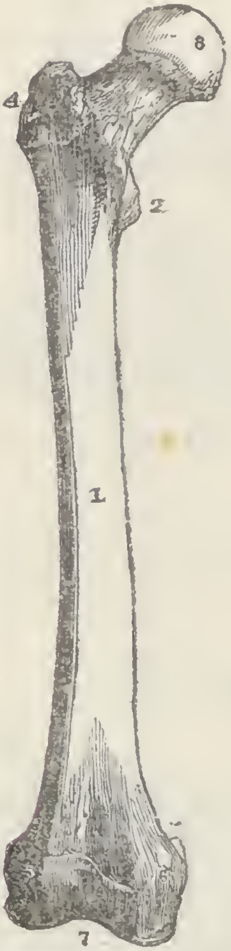
How many bones in the wrist? Where is the first range of finger bones placed? The first bone of the thumb? Describe Figs. 29 and 30.

The PHALANGES, or fingers, have *three* ranges of bones, while the thumb has but *two.* The bones of the hand and fingers are hollow, and enlarged at each extremity, like the bones of the arm and fore-arm. The articulation of the fingers is similar to that of the elbow and shoulder joints.

BONES OF THE LOWER EXTREMITIES.

The lower extremities contain the *femur*, or thigh bone, the *patella*, or knee pan, the *tibia*, the *fibula*, seven

Fig. 31.



1, Represents the shaft of the thigh bone. 2, A projection, named the trochantar minor, to which some strong muscles are attached. 4, Trochantar major, to which the large muscles of the hips are united. 3, The round head that enters into the formation of the hip joint. 5, External condyle of the femur. 6, Internal condyle. 7, The surface of the lower extremity of the thigh bone, that articulates with the tibia, and upon which the patella slides.

How many ranges of bones have the fingers? The thumb? What is their structure? Name the bones of the lower extremities.

bones of the *tarsus*, or instep, five *metatarsal* bones, and fourteen bones of the toes; making in both limbs sixty.

The FEMUR is the longest bone in the system. It supports the weight of the head, trunk, and upper extremities. At its upper extremity, the large, round head is placed in the *acetabulum*. This articulation is a perfect specimen of the ball and socket joint.

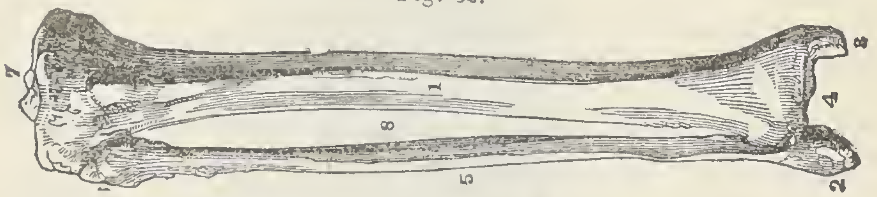
This bone articulates with the tibia at its lower extremity.

The PATELLA is a small bone connected with the tibia by a strong ligament. The tendon of the extensor muscles of the leg is attached to its upper edge. This bone is placed on the anterior part of the lower extremity of the femur, and acts like a pulley in the extension of the limb.

The TIBIA, or shin bone, is the largest bone of the leg. It is of a triangular shape, and enlarged at each extremity.

The FIBULA is a smaller bone than the tibia, but of similar shape. It is firmly bound to the tibia, at each extremity. The tibia, united with the condyles of the femur, and assisted by the patella, forms the knee joint. The tibia and fibula, with one of the tarsal bones, called astragulus, form the ankle joint. This is a perfect specimen of the hinge joint.

Fig. 32.



1, Is the tibia. 5, The fibula. 8, The space between the two, filled with the interosseous ligaments. 6, The junction of the tibia and fibula at their upper extremity. 2, The external malleolar process, called the external ankle. 3, The internal malleolar process, called the internal ankle. 4, The surface of the lower extremity of the tibia, that unites with the astragulus to form the ankle joint. 7, The upper extremity of the femur, upon which the condyle of the femur rests.

The FOOT is composed of three sets of bones. The *tarsal, metatarsal* and *phalangeal.*

The TARSAL, seven in number, are of an irregular form, and firmly bound together, permitting but little movement.

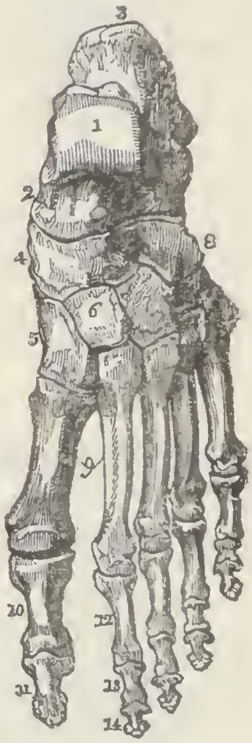
Describe the *femur*, or thigh bone. What kind of joint does it form? Describe the *patella*. The *tibia*. The *fibula*. How is the knee joint formed? How the ankle joint? How many sets of bones in the foot? How many *tarsal* bones?

The METATARSAL bones are five in number. They articulate at one extremity with one range of tarsal bones; at the other extremity, with the first range of the toe bones.

The seven *tarsal*, and five *metatarsal* bones are united so as to give the foot an arched form, convex above, and concave below. This structure conduces to the elasticity of the step, and the weight of the body is transmitted to the ground by the spring of the arch, in a manner which prevents injury to the numerous organs.

The PHALANGES, or toe bones, are fourteen in number; each of the small toes has three ranges of bones, while the great toe has but two.

Fig. 33



1, Is the surface of the astragulus, where it unites with the tibia. 2, Body of the astragulus. 3, Calcis, or heel bone. 4, Scaphoid bone. 5, 6, 7, Cuneiform bones. 8, Cuboid. 9, Range of five bones, forming the metatarsus. 10, The first bone of the great toe. 11, Second bone. 12, 13, 14, Three phalanges of bones, forming the toes.

How many *metatarsal?* What form does the union of the bones give the foot? What protection does it give? How many *phalanges?* How many ranges of bones have the toes? How many the great toe?

Fig. 34.

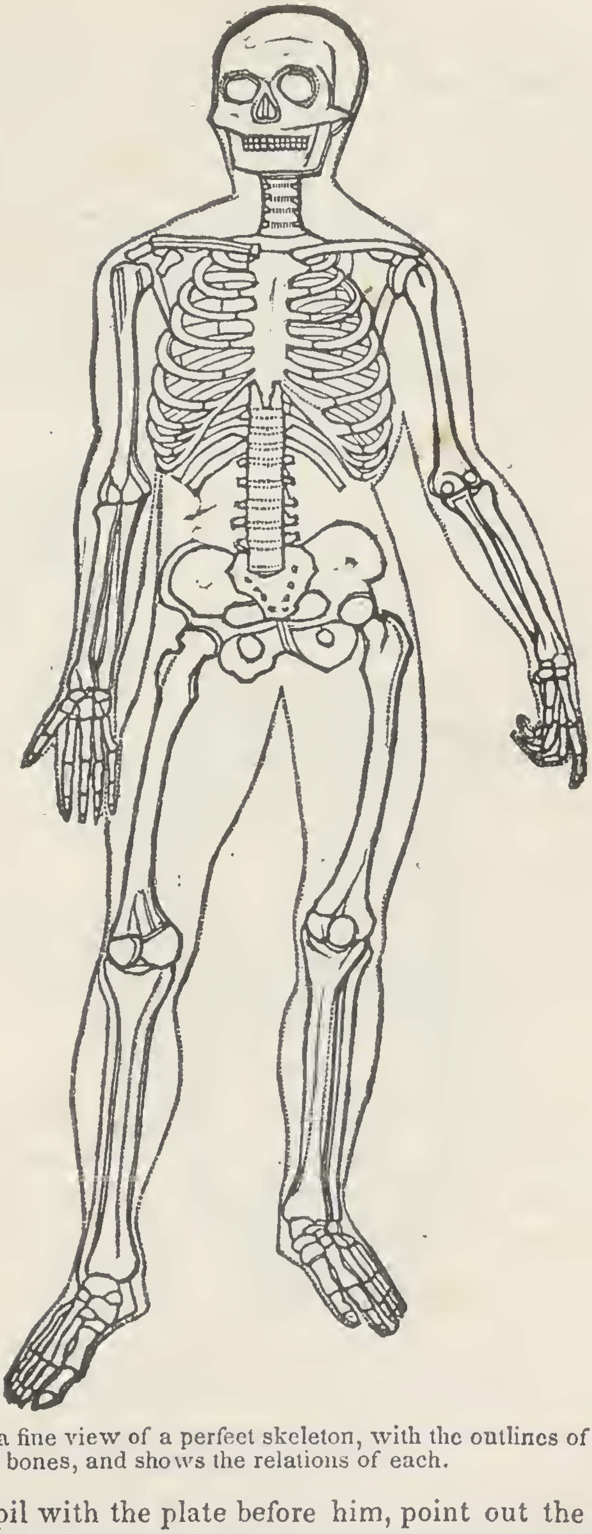


Fig. 34 gives a fine view of a perfect skeleton, with the outlines of the soft tissues surrounding the bones, and shows the relations of each.

Let the pupil with the plate before him, point out the situation of the *bones* in this skeleton; give their names, also a general description of each.

PERIOSTEUM.

This is a firm membrane that covers the bones, except where they are tipped with cartilage, and the crowns of the teeth, which are protected by enamel. This membrane has minute nerves, yet, like the bone, when healthy, it possesses but little sensibility. It is the nutrient membrane of the bone, endowing its exterior with vitality; it also gives insertion to the tendons and connecting ligaments of the joints.

When this membrane covers the skull, it is named the *pericranium*, from *peri*, around, and *kranon*, the skull.

COMPOSITION OF THE BONES.

The bones consist of a mixture of earthy and animal matter. The existence of the first is proved by burning them. By this process they are rendered white, their weight is lessened, and they become brittle, from the absence of animal matter. That which remains is composed of the carbonate and phosphate of lime.

The animal part can be made evident by immersing a bone in weak acid. This dissolves the salts of lime, and there remains a cartilaginous body, flexible and elastic, retaining the same form as the bone, and, like cartilage or gristle, it may be knotted.

These two substances are the component parts of bone. The earthy matter gives solidity and strength, while the animal part endows the bone with the principles of vitality.

OSSIFICATION OF THE BONES.

The bones experience many changes before they arrive at maturity. At their early formative stage, they are a *cartilage*, which is covered by the *periosteum*. At this period, the vessels of the cartilage convey only the *white* portion, or lymph of the blood. Subsequently they convey *red* blood. At this time *true* ossification commences at certain centres, which are called *the points of ossifica-*

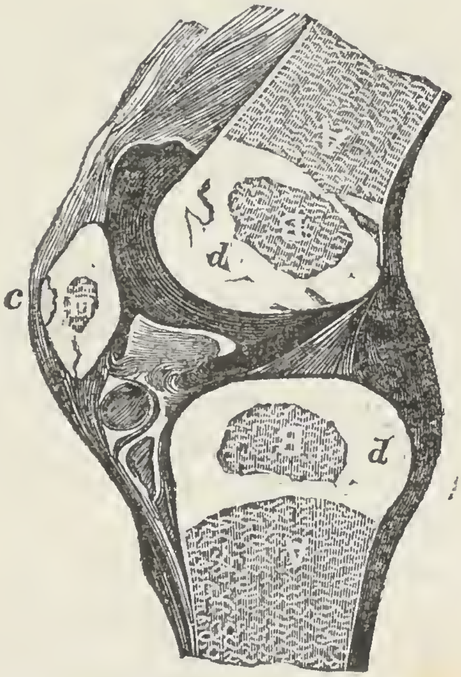
Describe the *periosteum*. Does this membrane possess sensibility? What is it called on the skull? Of what are the bones composed? How demonstrated? What is the use of these two parts? Do bones change previous to maturity? When they are cartilaginous, what fluid passes through them? When does true ossification commence?

tion. Most of the bones are formed of several pieces. This is seen in the long bones which have their extremities separated from the body, by a thin partition of cartilage. It is some time before these separate pieces are united to form one bone.

When the ossification is completed, the bones still continue to undergo different changes. They increase in bulk, and become less vascular, until middle age. In advanced life, the elevations upon their surface and near the extremities, become more prominent, particularly in individuals accustomed to labor. As a person advances in years the vitality diminishes, and, in extreme old age, the earthy substance predominates; consequently, they are extremely brittle.

The bones are not only supplied with *organic nerves* but with *arteries, veins,* and *lymphatics,* or *absorbents.*

Fig. 35.



This figure represents a section of the knee joint ; the lower part of the shaft of the thigh bone and upper part of the body of the leg bone, are seen ossified at A, A. The cartilaginous extremities of the two bones are seen at *d*, *d*. The point of ossification of the extremities, is seen at B, B. The patella, or knee pan, is seen at *c*: the point where ossification commences, at E.

What is said of the various changes of the bones after ossification ? With what are the bones supplied ?

PHYSIOLOGY OF THE BONES.

The bones are the frame-work of the system. By their solidity and form, they not only retain every part of the fabric in its proper shape, but afford a firm surface for the attachment of the muscles and ligaments. To give a clear idea of the relative uses of the bones and muscles, I will quote the comparison of another, though, as in other comparisons, there are points of difference. The 'bones are to the body what the masts and spars are to the ship, — they give support and the power of resistance. The muscles are to the bones what the ropes are to the masts and spars. The bones are the levers of the system. By the action of the muscles their relative positions are changed. As the masts and spars of a vessel must be sufficiently resistive and firm to sustain the action of the ropes, so the bones must possess the same qualities to sustain the action of the muscles in the human body.' We find them characterized by hardness, inflexibility, insensibility, and strength. By means of the bones the human frame presents to the eye a wonderful piece of mechanism, uniting the most finished symmetry of form with freedom of motion, and also giving security to many important organs.

Some of the bones are designed exclusively for the protection of the organs which they enclose. Of this number are those that form the skull, the sockets of the eye, and the cavity of the nose. Others, in addition to the protection they give to important organs, are useful in movements of certain kinds. Of this class are the bones of the spinal column and ribs. Others are subservient to motion. Of this class are the bones of the upper and lower extremities.

PRACTICAL SUGGESTIONS.

The health of the bones depends upon a supply of nutrient blood, and proper exercise. As a general thing, we see that among active and industrious men, when digestion is good, the lungs healthy and well-developed, with an abundant supply of pure air, they have also well-developed and well-formed limbs. On the contrary, persons who toil in damp rooms, who sleep in badly venti-

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What are the bones said to be? What are their uses? What are the different offices of the bones? Upon what does the health of the bones depend?

lated chambers, whose food is poor in quality and deficient in quantity, who pursue a laborious and exhausting occupation for many hours continuously, and in unnatural positions,—will have their bones more or less diseased.

The amount and kind of labor should be adapted to the age, health, and developement of the bones. The bending bones of the child, and the brittle bones of the aged man, are not adapted, by their organization, to long-continued and hard labor. Neither are the yielding bones of the child fitted for long-continued sitting, or standing in one position. The attempt to induce a child to stand or walk, while very young, is unwise, and often productive of injury to the system. The lower limbs being imperfectly developed, there being in them but a small amount of the earthy salts, bend when the weight of the body is thrown upon them for any length of time.

The bones that compose the spinal column and the ribs are, in the child, very soft and yielding. Such being the case, the clothing should be loosely applied to the child. A very small amount of pressure upon the gelatinous ribs, will push them in upon the lungs, heart, liver, stomach, and other important internal organs. The hip bones of the child, also, like the other bones, are soft and yielding. If the child be carried much upon one arm around the parlor, deformity may be produced. When it becomes older, the gelatine gives place to the earthy matter, which renders the bones firm to resist the action of the more mature muscles, and the forces operating upon them. As the child advances in years, the bones bend less easily, and are fractured more readily. In middle age, the proportion of gelatine, and the carbonate and phosphate of lime, are more nearly balanced. They are at this period of life, firm, elastic, and not so readily injured as in younger years, or more advanced life. In advanced life, as they are found to be friable or brittle, if they are fractured, it will require a greater length of time to unite them than in middle age; for the reason, that the gelatine is diminished, while the salts of lime have been very much increased.

Should labor be adapted to the developement of the bones? Why should not the clothing of children be tightly worn? Should they be carried in one position? How does the animal part of the bones compare with the earthy in childhood? In middle age? In old age? What is the effect of a predominance of earthy matter?

CHAPTER IV.

ANATOMY OF THE JOINTS.

THE joints are composed of the *extremities of the bones, cartilages, synovial membrane,* and *ligaments.*

CARTILAGE is a smooth, solid, elastic substance, softer than bone, and forms upon their articular surfaces, a thin incrustation.

The SYNOVIAL MEMBRANE is a thin, membranous layer, which invests the articular cartilages of the bones, and is thence reflected upon the surfaces of the ligaments which surround and enter into the composition of joints. It is a shut sac, and in this respect, resembles the serous membranes. Besides the synovial membranes, there are numerous smaller sacs of a similar kind, interposed between the surfaces which move upon each other, so as to cause friction; these small sacs are often associated with the articulations. These are the *bursæ mucosæ.* They are shut sacs, analogous in structure to synovial membranes, and secrete a similar synovial fluid.

Like the bones, the cartilages, ligaments, and synovial membranes are insensible when in health; yet they are supplied with *organic* nerves, arteries, veins, and absorbents.

The LIGAMENTS, (from the Latin, *ligare,* to tie,) are composed of numerous straight fibres, collected together and arranged into short bands of various breadth, or so interwoven as to form a broad layer, which completely surrounds the articular extremities of the bones, and constitutes a capsular ligament. These connecting bands are inelastic, glistening, and possess no sensibility when in

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Name the different parts of a joint. Describe *cartilage.* Describe the *synovial membrane.* What does it resemble? Describe the bursæ mucosæ. What is said of the sensibility of the cartilages and other parts of the joints? Of what are ligaments composed? What is the character of these connecting bands?

health. They are found exterior to the synovial membrane.

Fig. 36.

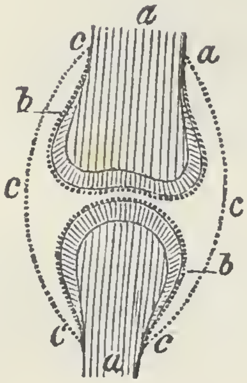


Fig. 37.

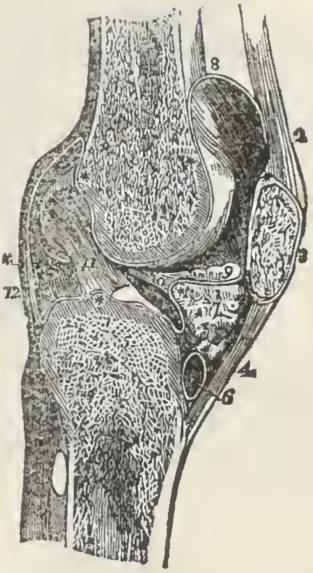
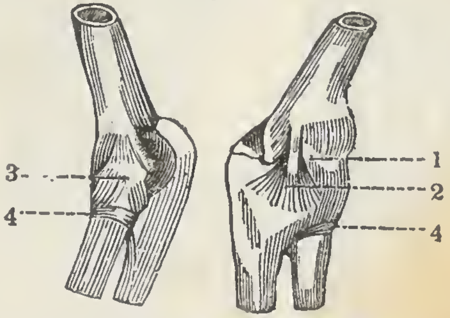


Fig. 36 gives the relative position of the bone, cartilage, and synovial membrane. The bones are indicated by *a*, *a*; *b*, *b*, point out the cartilage covering the ends of these bones; outside of this you see a dotted line, *c*, *c*; this is the synovial membrane, which envelopes the heads of both bones, and is then doubled back from one to the other.

Fig. 37 finely illustrates the relation of the extremities of the bones, cartilages, synovial membranes, and bursæ mucosæ, in the formation of joints. 1, The femur divided, the articular extremity of which is seen covered by a cartilage. 5, The tibia divided and likewise covered by an articular cartilage. 2 and 4, Ligaments attached to the patella, (3). * * * * is the synovial membrane, covering the cartilage that encrusts the extremity of the bones, from which it passes to line the ligaments seen at 12, 2, and the patella at (3). 9, 10, 11, Represent ligaments within the knee joint. 6, A bursa mucosa, seen under the tendon that connects the patella and tibia. 7, A mass of fat found around joints. By comparing Figs. 36 and 37, a good idea of the structure and arrangement of joints can be acquired.

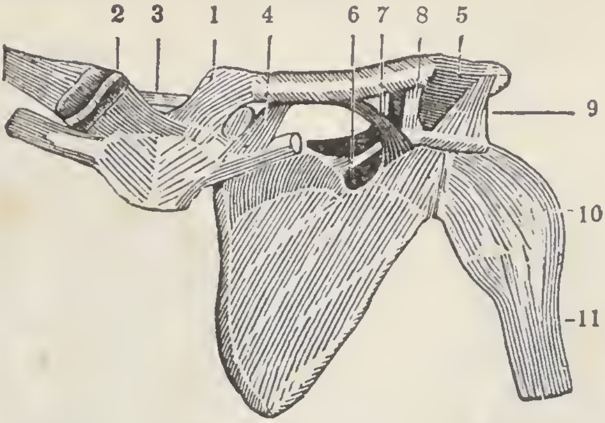
Fig. 38.



In this figure we have a view of the short, strong ligaments about the elbow joint. The wonder is, that the elbow can be dislocated without entirely ruining the entire ligamentary arrangement. The figures, from 1 to 4, not only give the locality, but even the form of the ligaments.

Where are they to be found? What do figs. 36 and 37 show?

Fig. 39.



'This cut exhibits the union of the shoulder blade, or *scapula*, the collar bone, or *clavicle*, the *sternum*, or the breast bone, and the shoulder joint. These are detached from the body; hence the view is a front one. A portion of the collar bone of the right side is also exhibited,—all the others being on the left side. The figures, from 1 to 11, indicate the ligaments that keep them united when the muscles have been removed by dissection.'

Fig. 40.

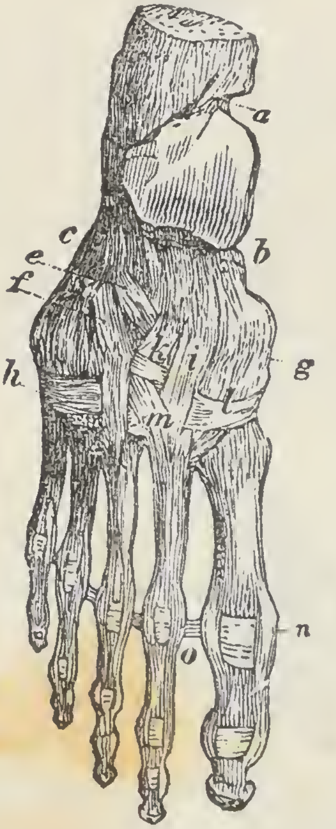


Fig. 41.

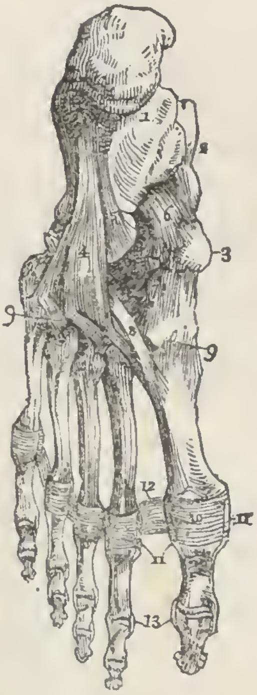
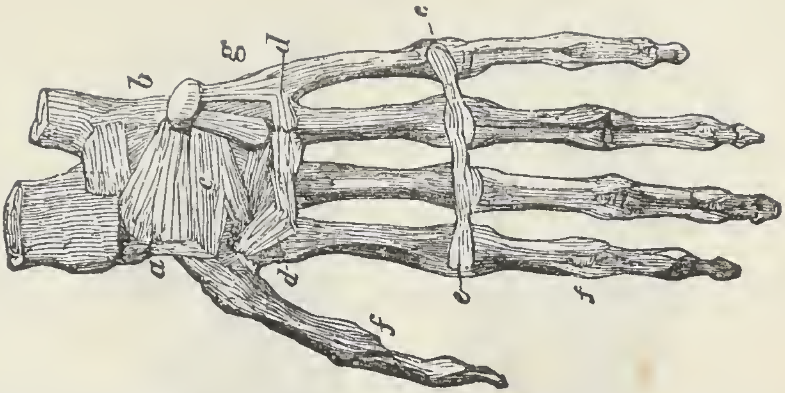


Fig. 40 is a view of the upper, 41 of the lower surface of the foot. These engravings show how the bones of the instep and ankle are articulated: how the instep and phalanges or toe bones meet; and lastly, the small letters and figures show the locality of each ligament, which assists in binding this congeries of large and small blocks firmly together. No one of these bones can be displaced, without the laceration of some of the ligaments, situated on both surfaces of the foot.

Fig. 42.



'Complex as the ligaments appear in this plan, there is certainly an admirable simplicity, conducing exactly to the perfection of the frame of the hand. Each letter shows the place of each ligament, as found on dissection, joined to the bones, which are thus drawn together like so many wedges. It would be impossible for the most ingenious mechanic to take the dry bones of the hand and secure them together by wires, clasps, rivets, or straps, so strongly as nature has done it by means of these little shining ligaments.'

Fig. 43.

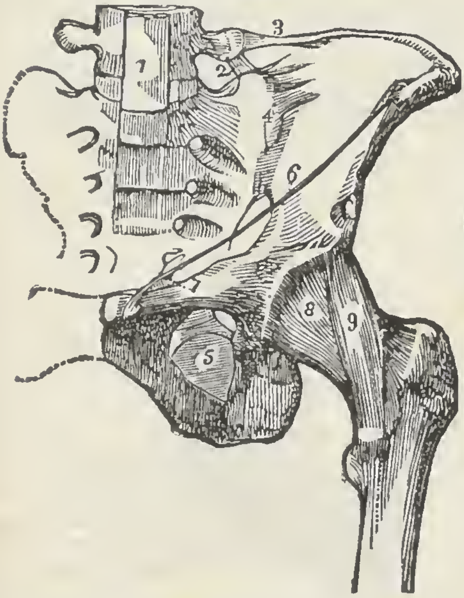


Fig. 44.

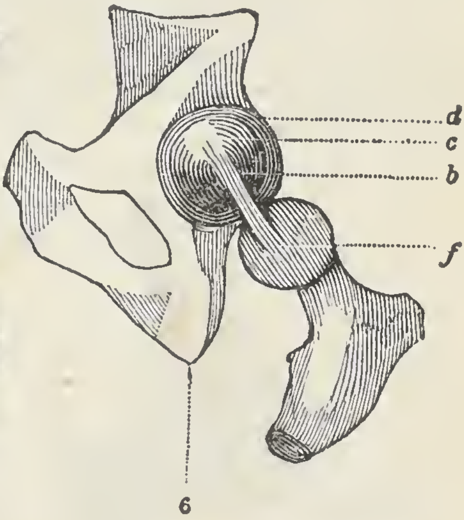


Fig. 43. The ligaments of the pelvis and hip joint. 1, The lower part of the anterior ligament of the vertebræ. 2, A ligament which extends from one of the vertebræ to the sacrum. 3, A ligament which extends from the vertebræ to the ilium. 4, Ligaments that connect the ilium and sacrum. 5, The obturator membrane. 6, Poupart's ligament. 7, Gimbernat's ligament. 8, The capsular ligament of the hip joint. 9, The ilio-femoral or accessary ligament.

Fig. 44 is a drawing of the lower part of the hip bone, or *os innominatum*, in which is seen the head of the thigh bone, tied into its socket by a short, round cord, to keep it in place. Were it not for these ligaments, *b*, 8, and 9, represented in fig. 43 and 44, a thousand unguarded movements would throw the hip out of place. *b*, is the cord that keeps the bones in the socket; *c*, the socket in the hip bone; *d*, a rim of the socket, to deepen it, and *f*, the head of the thigh bone. 6, The point of the bone on which we sit.

Fig. 45.

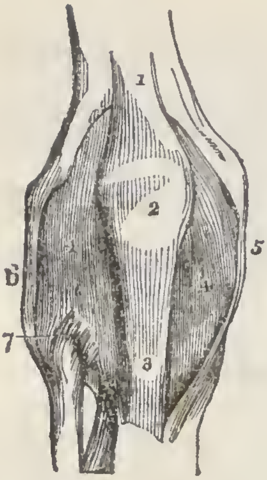


Fig. 46.

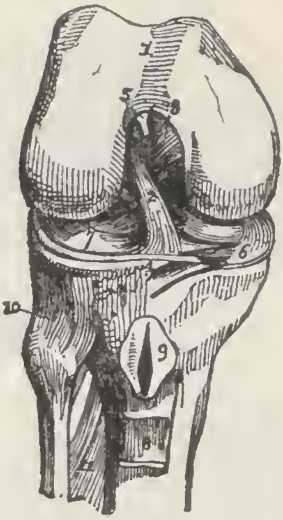


Fig. 45 represents the anterior ligaments of the knee joint. 1, The tendon of the quadriceps extensor muscle of the leg; 2, the patella; 3, the anterior ligament of the patella, near its insertion; 4, 4, the synovial membrane; 5, the internal lateral ligament; 6, the long external lateral ligament; 7, the anterior and superior ligament that unites the fibular bone to the tibia.

Fig. 46. 1, The articular extremity of the thigh bone. 2, 3, Crucial ligaments of the knee. 6, 7, Semilunar cartilages of the knee joint. 8, Attachment of the ligament of the patella to the tibia. 9, A bursa mucosa under this ligament. 10, Ligament that binds the tibia and fibula together. 11, Interosseous ligament between the tibia and fibula.

Fig. 47.

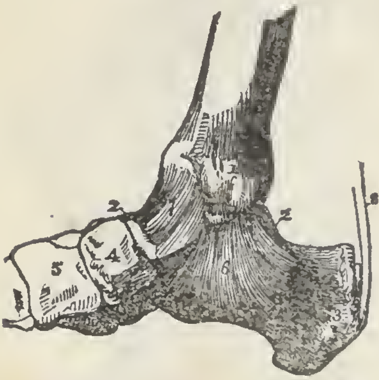


Fig. 48.

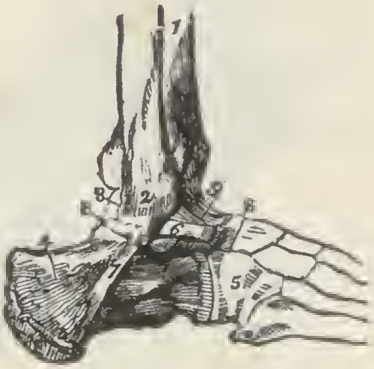


Fig. 47. An internal view of the ankle joint. 1, The internal malleolus of the tibia. 2, The astragulus bone. 3, The os calcis, or heel bone. 4, Scaphoid bone. 5, Cuneiform bone. 6, A strong ligament running from the point of the tibia to the calcis. 7, A ligament passing from the tibia to the astragulus. 8, The tendo Achilles, or heel cord.

Fig. 48. An external view of the ankle joint. 1, The tibia. 2, The external malleolus of the fibula. 3, 3, The astragulus. 4, The os calcis. 5, The cuboid bone. 6, The anterior fasciculus of the external lateral ligament, attached to the astragulus. 7, Its middle fasciculus, attached to the os calcis. 8, Its posterior fasciculus, attached to the astragulus. 9, The anterior ligament of the ankle.

As the joints of animals resemble those of man, it would be a good exercise for the student to examine those of the ox or calf. The satin-like bands, called ligaments, will be seen running from one bone to the other, under which will be seen the membranous bag, called the capsular ligament. This is seen to be very smooth, as it is lined with the soft synovial membrane; beneath which is seen the cartilage, that may be cut with a knife, and under this is seen the rough extremity of the ends of the bone.

PHYSIOLOGY OF THE JOINTS.

The extremities of the bones which assist in forming the joints, are porous in their texture, and consequently, more elastic, than if they were more compact. These are covered with a cushion of cartilage. The highly elastic and yielding character of these parts, serves to diminish the jar which the important organs of the system would otherwise receive.

The *synovial membrane* secretes a viscous fluid, which is called *synovia*, from the Greek, *sun*, (together,) and *óon*, (an egg.) This lubricating fluid of the joints enables the surfaces of the bones and tendons to glide smoothly over each other; thus diminishing the friction consequent on their action. In this is manifested the skill and omnipotence of the Great Architect. For no machine of human invention supplies to itself, by its own operations, the necessary lubricating fluid. But, in the animal frame, it is supplied in proper quantities, and applied in the proper place, and at the proper time.

It is by the agency of the *ligaments*, that the many small bones of the wrist and foot, as well as the larger bones of the system, are so securely bound together. Some of them are situated within the joint, like a central cord or pivot, (fig. 44.) Some surround it like a hood, and contain the lubricating, synovial fluid, (as seen at 10, fig. 39, and 8, 9, fig. 43,) and some are in the form of bands at the side, (fig. 42.)

Do the joints of animals resemble those of man? What renders the extremities of the bones more elastic than their centres? What is synovia? Its office? Mention an instance of the superiority of the animal machine over any of human invention. What is the use of *ligaments?*

The ligaments bind the lower jaw to the temporal bones, and the head to the neck. They extend the whole length of the spinal column, in powerful bands, both on the outer surface, within the spinal canal, and from one spinous process to another. They bind the ribs to the vertebræ, to the transverse process behind, and to the sternum in front; and this to the clavicle; and this to the first rib and scapula; and this last to the humerus; and this to the two bones of the fore-arm at the elbow joint; and these to the wrist; and these to each other and to those of the hand; and these last to each other and those of the fingers and thumb. In the same manner, also, they bind the bones of the pelvis together, and the innominatum to the femur, and this to the two bones of the leg and patella, and so on, to the ankle, and foot, and toes, as in the upper extremities. Thus the whole osseous system is united and bound together in the most powerful and admirable manner, so as to possess, in a wonderful degree, mobility and firmness.

PRACTICAL SUGGESTIONS.

It is seldom that a bone is displaced without injury to the connecting ligaments and membranes. When these connecting bands are lacerated, pain, swelling, and other symptoms indicating inflammation, succeed, which should be removed by proper treatment by a surgical adviser.

In *sprains*, but few if any of the fibres of the connecting ligaments are lacerated; but they are unduly strained and twisted, which occasions acute pain at the time of the injury. This species of injury to the system is followed by inflammation and weakness of the joints. The treatment of these injuries is similar to that of a dislocated bone after its reduction. The most important thing is *rest.*

In persons of scrofulous constitutions, and those in whom the system is enfeebled by disease, — *white swellings*, and other chronic diseases of the joints, frequently succeed *sprains.* Such persons cannot be too assiduous in adopting a proper and early treatment of injured joints.

When we sprain a joint what are injured? What treatment should be adopted?

CHAPTER V.

ANATOMY OF THE MUSCULAR SYSTEM.

Muscles are the moving organs of the animal frame. They constitute, by their size and number, the great bulk of the body, upon which they bestow form and symmetry. In the limbs, they are situated around the bones, which they invest and defend, while they form, to some of the joints, their principal protection. In the trunk, they are spread out to enclose cavities, and constitute a defensive wall, capable of yielding to internal pressure, and returning again to its original form.

Their color is a deep red, which is characteristic of *flesh*, and their form is variously modified, to execute the varied range of movements which they are required to effect.

Muscle is composed of a number of parallel fibres, placed side by side, and supported and held together by a delicate web of cellular tissue. Towards the extremity of the organ the muscular fibre ceases, and the cellular structure becomes aggregated and so modified as to constitute those cords called tendons, by which the muscle is tied to the surface of the bone. The union is so firm, that, under extreme violence, the bone will sooner break than permit the tendon to separate from its attachment.

In the broad muscles, the tendon is spread so as to form an expansion called *aponeurosis*. Muscles present various modifications in the arrangement of their fibres in relation to their tendinous structure. Sometimes they are completely longitudinal, and terminate, at each extremity, in a tendon, the entire muscle being *fusiform* in shape. In other situations they are disposed like the rays of a fan, converging to a tendinous point, and consti-

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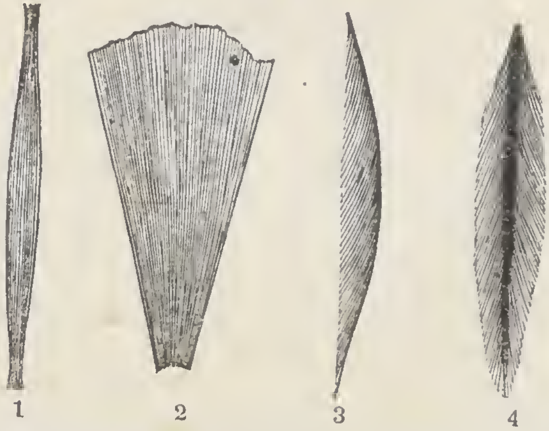
What are the muscles? What give symmetry of form to the human frame? How are they situated in the limbs? In the trunk? What is their color? Of what is muscle composed? Describe tendons. What is said of the union of the tendons with the bone? Describe some of the different forms of muscles.

tuting a *radiate* muscle. Again they are *penniform*, converging, like the plumes of a pen, to one side of a tendon, which runs the whole length of the muscle, or they are *bipenniform*, converging to both sides of the tendon.

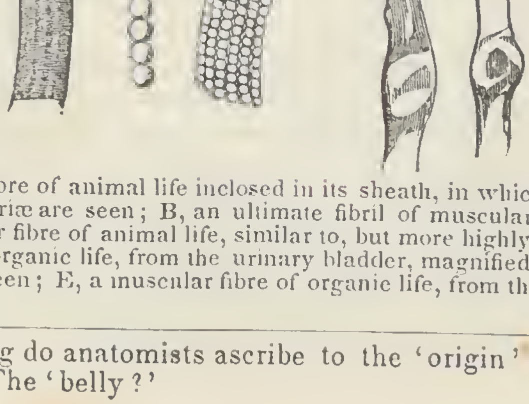
Fig. 49.



1, Represents the direction and arrangement of the fibres in a fusiform muscle; 2, in a radiated muscle; 3, in a penniform muscle; 4, in a bipenniform muscle.

In the description of a muscle, we express its attachment by the terms 'origin' and 'insertion.' The term *origin* is generally applied to the more fixed or central attachment, or to the point toward which motion is directed; while *insertion* is assigned to the more movable point, or to that most distant from the centre. The middle, fleshy portion, is called the 'belly.'

Fig. 50.

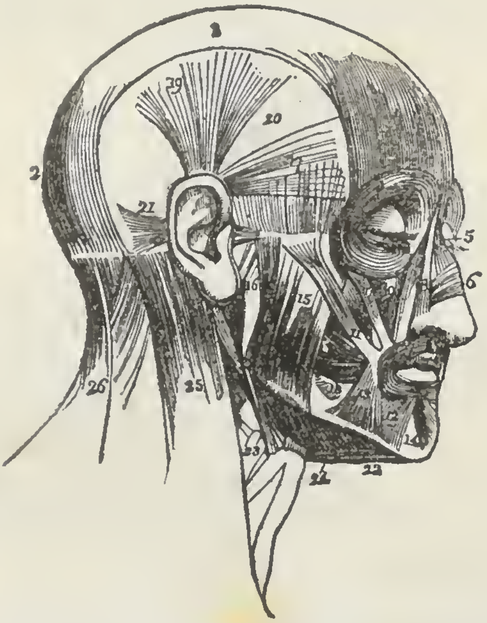


A, a muscular fibre of animal life inclosed in its sheath, in which the transverse and longitudinal striæ are seen; B, an ultimate fibril of muscular fibre of animal life. C, a muscular fibre of animal life, similar to, but more highly magnified; D, a muscular fibre of organic life, from the urinary bladder, magnified 600 times; two of the nuclei are seen; E, a muscular fibre of organic life, from the stomach, magnified 600 times.

What meaning do anatomists ascribe to the 'origin' of a muscle? 'Insertion?' The 'belly?'

In structure, muscle is composed of bundles of fibres, of variable size, called *fasciculi.* These are enclosed in a cellular, membranous investment, or sheath. Each *fasciculus* is composed of a number of smaller bundles of single fibres. These have been distinguished by the name of *ultimate fibres.* The ultimate fibres consist of a number of *ultimate fibrils*, enclosed in a delicate sheath.

Fig. 51.



1 Is the frontal portion of the occipito frontalis. 2, Its occipital portion. 3, Its aponeurosis. 4, Orbicularis palpebrarum. 5, Pyramidalis nasi. 6, Compressor nasi. 7, Orbicularis oris. 8, Levator labii superioris alæque nasi. 9, The levator superioris proprius. 10, Zygomaticus major. 11, Zygomaticus minor. 12, Depressor labii inferioris. 13, Depressor anguli oris. 14, Levator labii inferioris. 15 and 16, Masseter. 17, Attrahens aurem. 18, Buccinator. 19, Attollens aurem. 20, Fascia of temporal muscle. 21, Retrahens aurem. 22, Belly of digastric muscle. 23, Stylo hyoid muscle. 24, Mylo hyoid muscle. 25, Upper part of sterno mastoid muscle. 26, Upper part of the trapezius.

8 and 9, are the muscles that elevate the upper lip. 12, The muscle that depresses the lower lip. 10 and 11, the muscles that elevate the angle of the mouth. 13, The muscle that depresses the angle of the mouth. 7, The muscle that closes the mouth. 15 and 16, The muscles that bring the upper and lower jaw in opposition, in masticating food. 25, The muscle that brings the head forward in bowing.

NOTE. — Let the pupil, in describing the engravings of the muscular system, call into action the different muscles ; as, in elevating the angle of the mouth by contracting muscles 10 and 11. The effect of the contraction of other muscles on the system, and their attachments, can be noted in the same manner. (Refer to fig. 71, Physiology of the Muscles.)

What is a *fasciculi* of a muscle ? Explain the office of the different muscles represented in fig. 51, from the cut. *Likewise, explain the following engravings on the muscular system in a similar manner.*

Two kinds of muscular fibres exist in the animal economy, viz. that of voluntary, or animal life, and that of involuntary, or organic life.

The fibre of animal life is marked by transverse striæ, or channels; the fibre of organic life has no transverse striæ, and is much smaller than the fibre of animal life. The most remarkable characteristic of organic life is the existence from point to point of swellings somewhat larger than the diameter of the fibre.

Fig. 52.

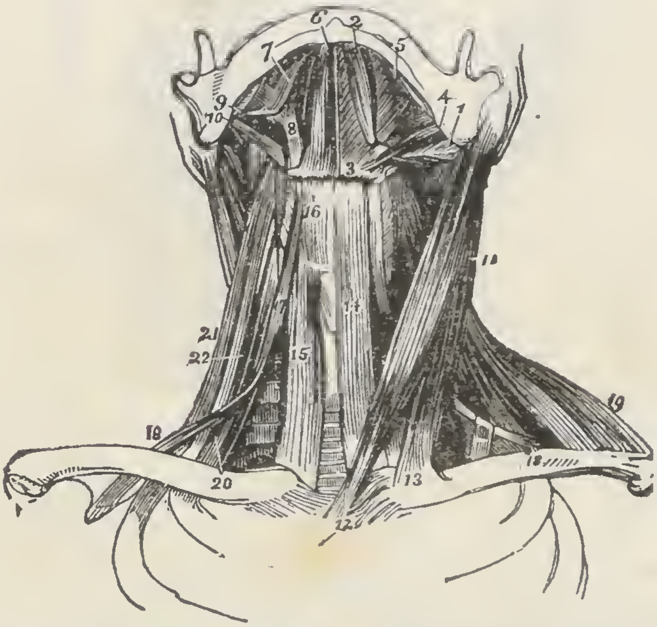


Fig. 52 represents the muscles of the anterior part of the neck; on the left side the superficial muscles are seen; on the right the deep seated muscles. 1, The posterior belly of the digastricus. 2, Its anterior belly. 3, The os hyoides. 4, The stylo-hyoideus. 5, The mylo-hyoideus. 6, The genio-hyoideus. 7, The tongue. 8, The hyo-glossus. 9, The stylo-glossus. 10, The stylo-pharyngeus. 11, The sterno-mastoid. 12, The sternum. 13, The clavicle. 14, The sterno-hyoid. 15, The sterno-thyroid. 16, The thyro-hyoid. 17 and 18, The omo-hyoid. 19, A portion of the trapezius. 20, The scalenus anticus. 21, The scalenus posticus.

The muscles 1, 2, 4, 5, 6, and 8, are attached to the lower jaw at one extremity, and to the os hyoides at the other. When the jaw is fixed, by their contraction, the hyoid bone is elevated. If the os hyoides is fixed, their contraction depresses the jaw. The muscle 11, is attached to the sternum and clavicle at one extremity, and to the skull bone behind the ear at the other extremity. By its contraction, the head is drawn forward, as in the act of bowing, when the sternum is fixed; but if the head is fixed, the sternum is elevated, as in respiration. When the muscle on one side only contracts, the face is turned toward the opposite shoulder. 14, 15, 16 and 17, connect the os hyoides with the sternum. By their contraction the hyoid bone is depressed when the sternum is fixed. Sometimes they assist in elevating the sternum.

How many kinds of muscular fibre in the animal economy? How is the fibre of animal life marked? Of organic life? What is the most remarkable characteristic of organic life?

Every muscle and each muscular fibre is supplied with arteries, veins, absorbents, and both sentient and motive nervous filaments.

The number of muscles in the human body is more than four hundred; in general, they form about the skeleton two layers, and are distinguished into superficial and deep-seated. The names of the different muscles, or a description of them separately, are not given, on account of their number; and acquiring their names would not only be tedious, but of no *practical* utility.

Fig. 53.

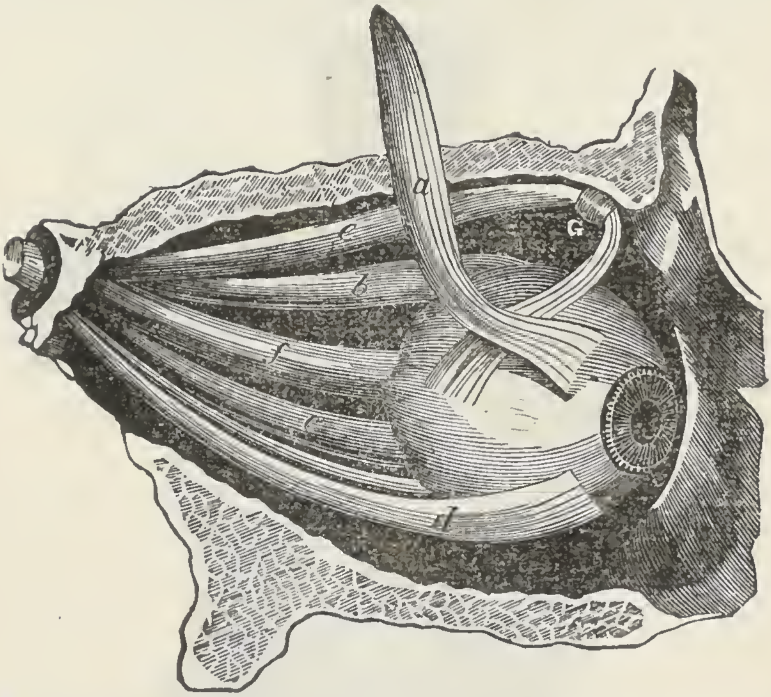


Fig. 53, represents the muscles of the eye. The bone above and below the eye is seen in its relative position. *a*, The external rectus muscle, the posterior attachment separated and raised. *b*, The superior rectus. *c*, The internal rectus. *d*, The inferior rectus. *e*, The superior oblique. *g*, The trochlea, or pulley through which its tendon passes. The use of this tendon is to change the direction of the action of this muscle. *f*, The optic nerve.

The muscle *a*, turns the eye out. The muscle *b*, rolls it upward. The muscle *c*, turns it towards the nose. The muscle *d*, turns it downward. The muscle *e*, rolls it downward and inward.

Muscles are divided into two great classes; voluntary and involuntary. They may be arranged in conformity with the general division of the body, into — 1. Those of the head and neck. 2. Those of the trunk. 3. Those of the upper extremity. 4. Those of the lower extremity.

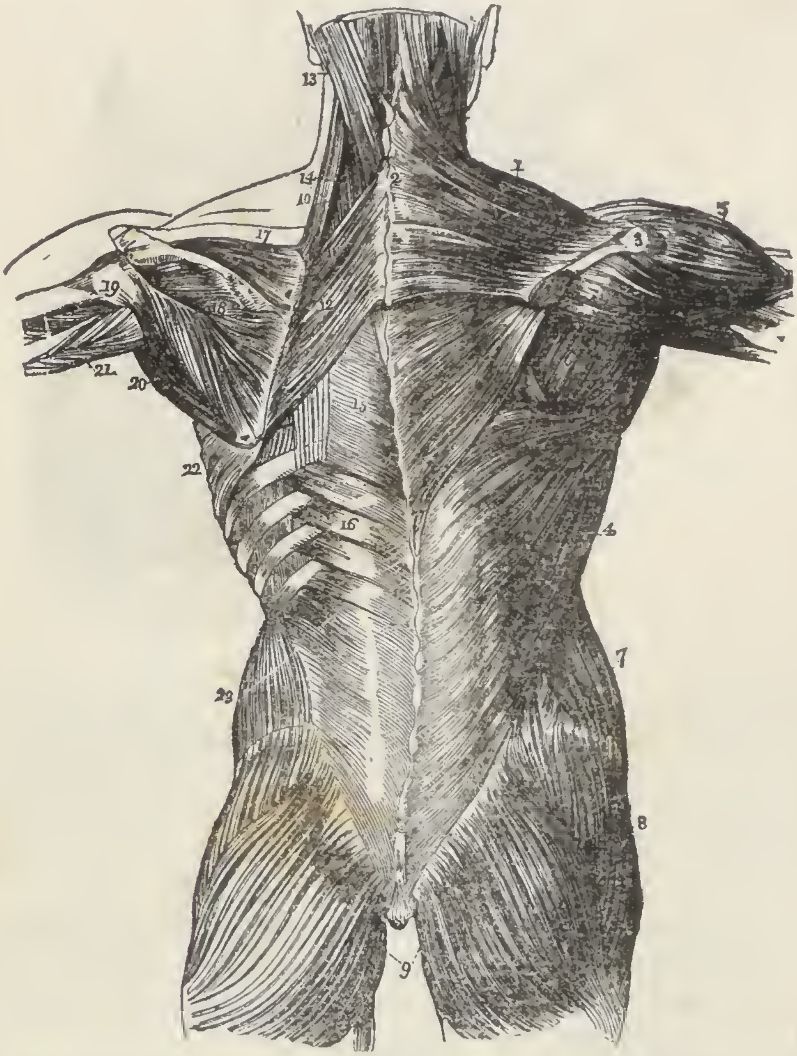
With what is every muscular fibre supplied? How many muscles in the human body? How distinguished? Into how many classes are muscles divided?

The muscles of the HEAD and NECK are represented in figs. 51, 52, 53. The interstices between the different muscles are filled with adipose matter or fat. To the presence of this tissue, the youth is indebted for roundness and beauty of form.

The muscles of the TRUNK may be thus divided — 1st. The muscles of the back. 2d. Those of the thorax and abdomen.

The muscles of the back are numerous, and may be arranged in six layers.

Fig. 54.



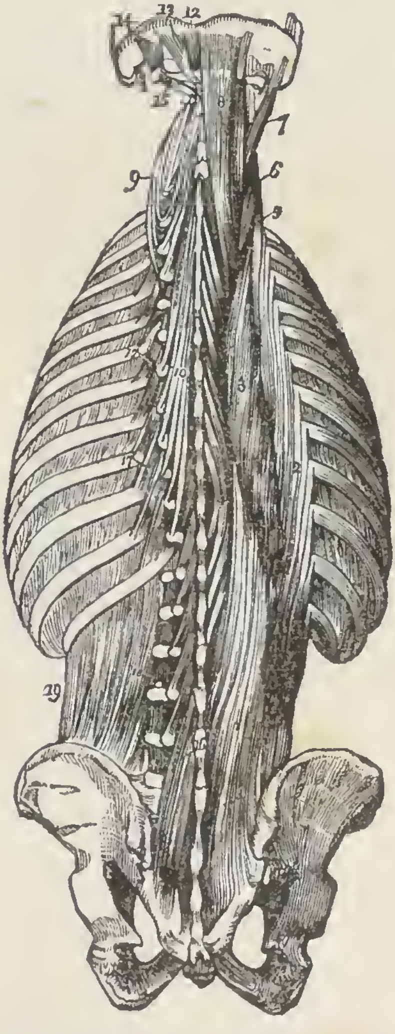
In fig. 54 the first, second, and part of the third layer of muscles of the back are represented. The first layer is shown on the right, and the second on the left side.

With what are the interstices between muscles filled?

1, The trapezius muscle. 2, The spinous processes of the vertebræ. 3, The acromion process and spine of the scapula. 4, The latissimus dorsi muscle. 5, The deltoid. 6, The muscles of the back of the scapula, named infra-spinatus, teres minor, and teres major. 7, The external oblique. 8, The gluteus medius. 9, The gluteus maximus. 10, The levator anguli scapulæ. 11 and 12, The rhomboideus major and minor. 13, The splenius capitis. 14, The splenius colli. 15, The vertebral aponeurosis. 16, The serratus posticus inferior muscle. 17, The supra-spinatus. 18, The infra-spinatus. 19, The teres minor. 20, The teres major. 21, The long head of the triceps, passing between the minor and major to the upper arm. 22, The serratus magnus, proceeding from its origin to the base of the scapula. 23, The internal oblique muscle.

The muscles 1, 11 and 12, draw the scapula back towards the spine. The muscles 10, 11 and 12, draw the scapula upward toward the head, and slightly backward. The muscle 4, draws the arm by the side, and backward. The muscles 5 and 17, elevate the arm. The muscles 8 and 9, extend the thigh on the body. The muscles 1, 13 and 14, draw the head back and elevate the chin. The muscles 18, 19 and 20, draw the arm to the side and roll the hand out. The muscle 16, depresses the ribs in expiration. The muscle 22 elevates the ribs in inspiration.

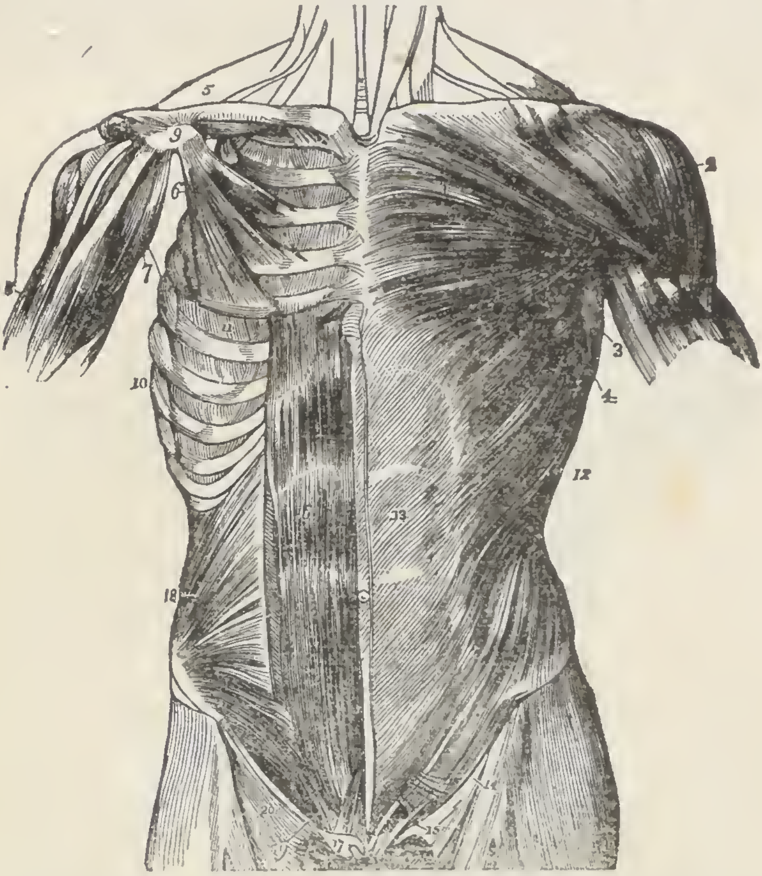
Fig. 55.



In fig. 55 the fourth, fifth, and part of the sixth layer of the muscles of the back is represented. 1, The erector spinæ muscle. 2, The sacro-lumbalis. 3, The longissimus dorsi. 4, The spinalis dorsi. 5, The cervicalis ascendens. 6, The transversalis colli. 7, The trachelo-mastoideus. 8, The complexus. 9, The transversalis colli. 10, The semi-spinalis dorsi. 11, The semi-spinalis colli. 12, The rectus posticus minor. 13, The rectus posticus major. 14, The obliqus superior. 15, The obliqus inferior. 16, The multifidus spinæ. 17, 17, The levatores costarum. 18, The intertransversalis. 19, The quadratus lumborum.

The muscles 1, 2, 3, 4, 10, 16, 18, and 19, by their contraction, keep the spinal column erect, when the muscles of both sides act; but when the muscles on one side only are called into action, the spine and body are curved laterally. The muscles 5, 6, 7, 8, 9, 11, 12, and 13, draw the head back and elevate the chin, when the muscles on both sides act; but when those on one side only contract, the head is drawn backward and to one side. The muscles 14 and 15, by their contraction, produce a rotary movement of the head. The muscles 17, 17, elevate the ribs in inspiration.

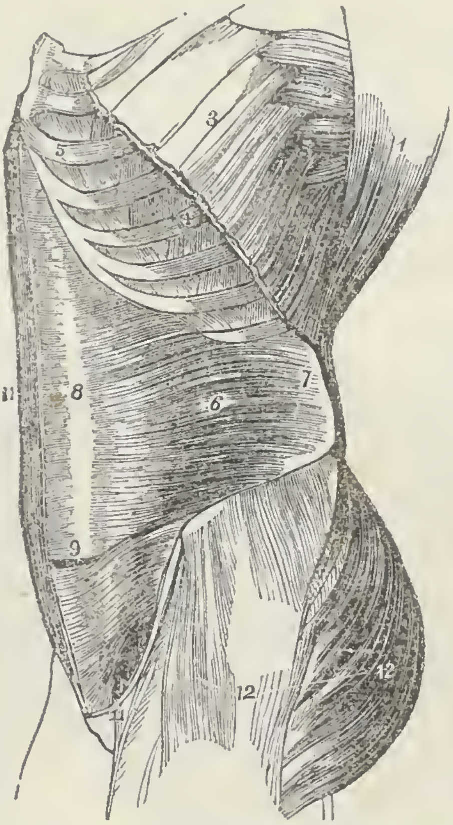
Fig. 56.



In fig. 56 the muscles of the anterior aspect of the trunk are represented. On the left side the superficial layer is seen; on the right, the deeper layer. 1, The pectoralis major muscle. 2, The deltoid. 3, The border of the latissimus dorsi. 4, The serrations of the serratus magnus. 5, The subclavius. 6, The pectoralis minor. 7, The coraco brachialis. 8, The upper part of the biceps, showing its two heads. 9, The coracoid process of scapula. 10, The serratus magnus of the right side. 11, 11, The external intercostal muscle. 12, The external oblique. 13, Its aponeurosis. 14, Poupart's ligament. 15, The external abdominal ring. 16, The rectus muscle of the right side. 17, The pyramidalis. 18, The internal oblique. 19, The conjoined tendon of the internal oblique and transversalis muscle. 20, The arch formed by the lower border of the external oblique muscle and Poupart's ligament. It is beneath this arch that the intestines pass in femoral hernia or rupture. 21, The psoas muscle. 22, The aperture for the saphena vein.

The muscle 1, draws the arm by the side, and across the chest, and likewise the scapula forward. The muscle 2, elevates the arm. The muscle 6 elevates the ribs when the scapula is fixed, or draws the scapula forward and downwards when the ribs are fixed. The muscles 12, 16, 17, and 18, bend the body forward or elevate the hips when the muscles of both sides act. They likewise depress the ribs in expiration. When the muscles on one side only act, the body is twisted to the same side.

Fig. 57.



In fig. 57 a lateral view of the trunk of the body is represented. 1, The costal origin of the lattissimus dorsi. 2, The serratus magnus. 3, The upper part of the external oblique. 4, Two of the external intercostals. 5, Two of the internal intercostals. 6, The transversalis. 7, Its posterior aponeurosis. 8, Its anterior aponeurosis. 10, The right rectus muscle. 11, The arched opening left by Poupart's ligament, through which femoral hernia passes. 12, 12, The gluteus maximus and tensor femoris muscles.

The recti muscles flex the thorax upon the chest, and, through the medium of the lineæ transversæ, are enabled to act when their sheath is curved inwards by the action of the transversales. The abdominal are expiratory muscles, and the chief agents of expulsion. By their action, the fæces are expelled from the rectum; the bile from the gall bladder; the ingesta from the stomach and bowels, in vomiting; and the mucus and irritating substances from the bronchial tubes, trachea, and nasal passages, during coughing and sneezing. To produce these effects they all act together. Their violent and continued action produces hernia; and acting spasmodically, they may occasion ruptures of the viscera.

The contraction and relaxation of the abdominal muscles and diaphragm, stimulate the stomach, liver, and intestines to a healthy action, and are subservient to the digestive powers. If the contractility of their muscular fibres is destroyed, or impaired, the tone of the digestive apparatus will be diminished, as is seen in indigestion and costiveness. This is frequently attended by a displacement of those organs, as they gravitate to the lower portion of the abdominal cavity, when several abdominal muscles lose their tone and become relaxed.

Fig. 58.

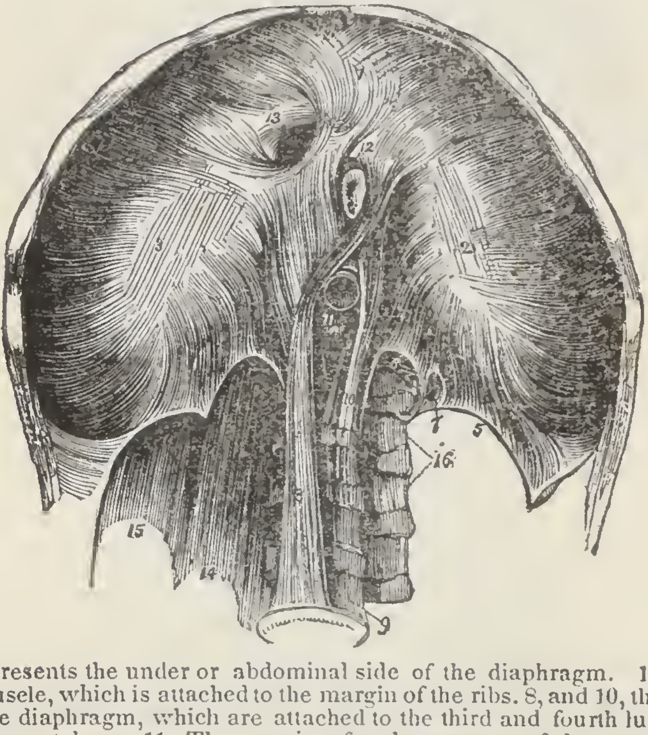


Fig. 58 represents the under or abdominal side of the diaphragm. 1, 2, 3, and 4, the larger muscle, which is attached to the margin of the ribs. 8, and 10, the two fleshy pillows of the diaphragm, which are attached to the third and fourth lumbar vertebræ. 9, The vertebræ. 11, The opening for the passage of the aorta. 12, The opening for the œsophagus. 13, The opening for the vena cava ascendens. 14, The psoas magnus muscle. 15, The quadratus lumborum.

The DIAPHRAGM is the muscular septum between the thorax and abdomen. It is composed of two portions, a greater and lesser muscle. The *greater muscle* arises from the ensiform cartilage; from the inner surface of the six inferior ribs. From these points which form the internal circumference of the trunk, the fibres converge and are inserted into the central tendon. The *lesser muscle* takes its origin from the lumbar vertebræ by two tendons.

MUSCLES OF THE EXTREMITIES.

The muscles of the UPPER EXTREMITIES are divided into, 1. The muscles of the arm. 2. The muscles of the fore arm. 3. The muscles of the hand.

The muscles of the arm are the subscapularis, teres major and minor, coraco-brachialis, biceps, brachialis internus and triceps. The biceps and brachialis internus bend the arm at the elbow; the triceps extends the arm on the same point. These muscles are attached at one extremity to the humerus and scapula, at the other to the ulna and radius.

Fig. 59.

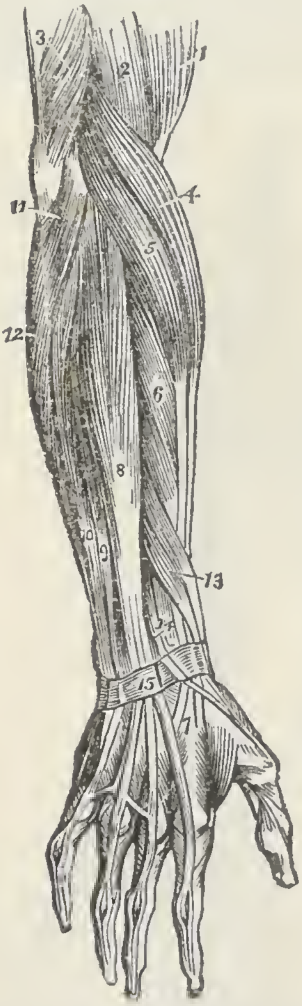


Fig. 60.

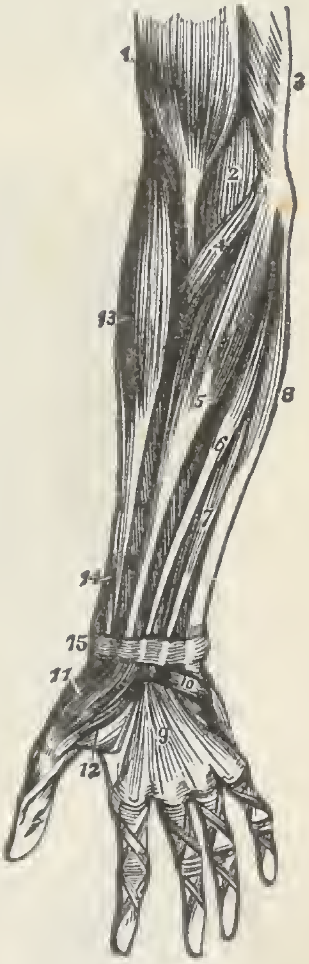


Fig. 59, represents the superficial layer of muscles on the posterior aspect of the fore arm. 1, The lower part of the biceps muscle. 2, Part of the brachialis anticus, 3, The lower part of the triceps inserted into the olecranon. 4, The supinator longus. 5, The extensor carpi radialis longior. 6, The extensor carpi radialis brevior. 7, The tendons of insertion of these two muscles. 8, The extensor communis digitorum. 9, The extensor minimi digiti. 10, The extensor carpi ulnaris. 11, The anconeus. 12, Part of the flexor carpi ulnaris. 13, The extensor ossis metacarpi, and extensor primi internodii lying together. 14, The extensor secundi internodii; its tendon is seen crossing the two tendons of the extensor carpi radialis longior and brevior. 15, The posterior annular ligament. The tendons of the common extensor are seen on the back of the hand, and their mode of distribution on the back of the fingers.

The muscles 5, 6, and 10, extend the wrist on the fore arm. The muscle 8, extends the fingers. The muscle 9, extends the little finger. The muscle 13, extends the metacarpal bone of the thumb, and its first phalanx. The muscle 14, extends the last bone of the thumb.

Fig. 60, represents the superficial layer of muscles on the anterior aspect of the fore arm. 1, The lower part of the biceps, with its tendon. 2. A part of the brachialis anticus seen beneath the biceps. 3, A part of the triceps. 4, The pronator radii teres. 5, The flexor carpi radialis. 6, The palmaris longus. 7, One of the fasciculi of the flexor sublimis digitorum; the rest of the muscle is seen beneath the tendons of the palmaris longus, and flexor carpi radialis. 8, The flexor carpi ulnaris. 9, The palmar fascia. 10, The palmaris brevis muscle. 11, The abductor pollicis. 12, One portion of the flexor brevis pollicis. 13, The supinator longus. 11, The extensor ossis metacarpi, and extensor primi internodii pollicis, curving around the lower border of the fore arm. 15, The anterior portion of the annular ligament, which binds the tendons in their places.

The muscles 5, 6, and 8, bend the wrist on the bones of the fore arm. The mus-

Fig. 61.

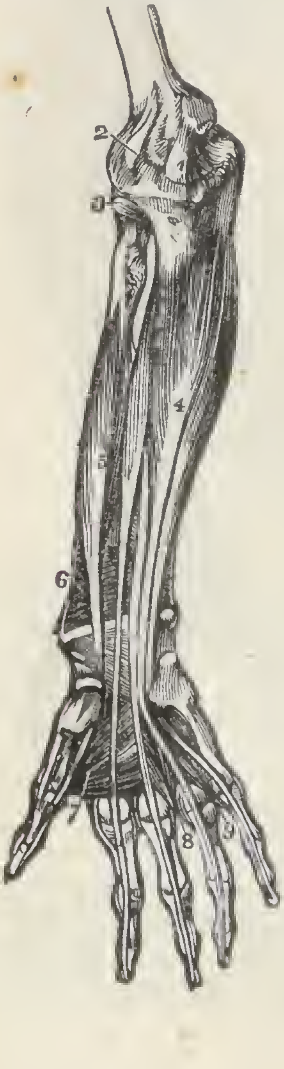
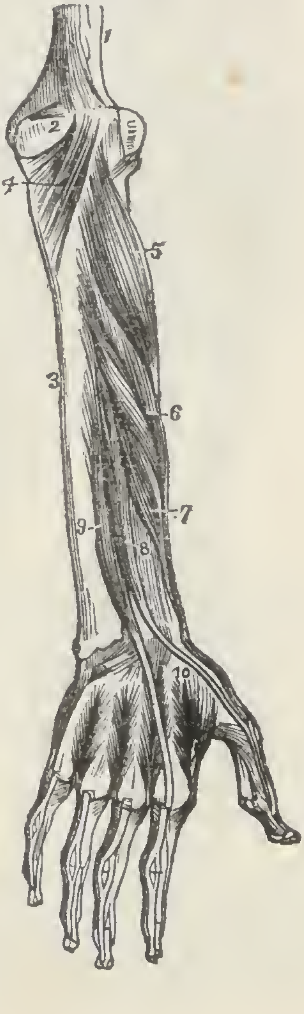


Fig. 62.



cle 7, bends the second range of finger bones on the first. The muscle 11, draws the thumb from the fingers. The muscle 12, flexes the thumb. The muscle 13, turns the palm of the hand upward.

Fig. 61, represents the deep layer of muscles on the anterior aspect of the fore arm. 1, The internal lateral ligament of the elbow joints. 2, The anterior ligament. 3, The orbicular ligament of the head of the radius. 4, The flexor profundus digitorum muscle. 5, The flexor longus pollicis. 6, The pronator quadratus. 7, The adductor pollicis. 8, 9, The dorsal interosseous muscle of the middle finger, and palmar interosseous of the little finger.

The muscle 4, bends the last range of finger bones upon the second. The muscle 5, bends the last joint of the thumb. The muscle 6, turns the back of the hand up. The muscle 7, draws the thumb towards the hand. The muscles 8, and 9, draw the bones of the hand towards each other.

Fig. 62, represents the deep layer of muscles on the posterior aspect of the fore arm. 1, The lower part of the humerus. 2, The olecranon. 3, The ulna. 4, The anconeus muscle. 5, The supinator brevis. 6, The extensor ossis metacarpi pollicis. 7, The extensor primi internodii pollicis. 8, The extensor secundi internodii pollicis. 9, The extensor indicis. 10, The first dorsal interosseous muscle. The other three dorsal interosseous muscles are seen between the metacarpal bones of their respective fingers.

The muscle 5, turns the palm of the hand up. The muscle 6, extends the metacarpal bone of the thumb. The muscles 7 and 8, extend the first and second bones of the thumb. The muscle 9, extends the fore finger.

Fig. 63.

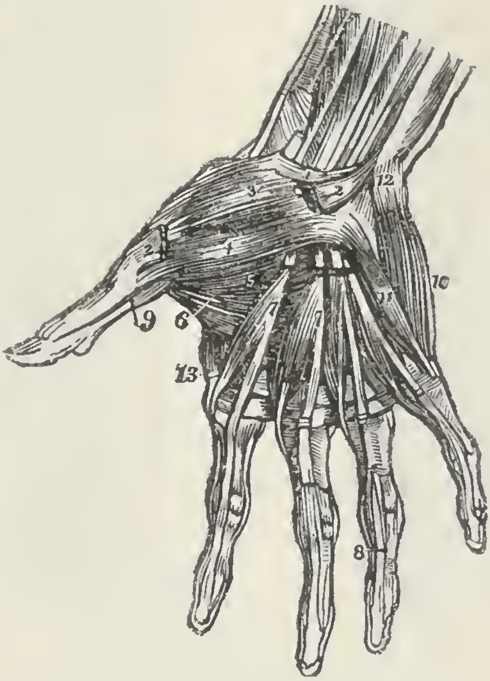


Fig. 63, represents the muscles of the hand. 2, 2, The origin and insertion of the metacarpi, or opponens pollicis. 4, One portion of the flexor brevis pollicis. 5, abductor pollicis muscle ; the middle portion has been removed. 3, The flexor ossis The deep portion of the flexor brevis pollicis. 6, The adductor pollicis. 7, 7, The lumbricales muscles, arising from the tendons of the deep flexor upon which the numbers are placed. The tendons of the flexor sublimis have been removed from the palm of the hand. 8, One of the tendons of the deep flexor, passing between the two terminal slips of the flexor sublimis to reach the last phalanx. All the tendons of the deep flexor pass through a similar slip in the tendons of the flexor sublimis. 9, The tendon of the flexor longus pollicis, passing between the two portions of the flexor brevis to the first phalanx. 10, The abductor mimini digiti. 11, The flexor brevis minimi digiti. 12, The prominence of the pisiform bone. 13, The first dorsal interosseous muscle.

The muscles 3, and 4, bend the metacarpal bone and first phalanx of the thumb. The muscles 5, and 6, draw the thumb towards the hand. The muscle 10 separates the little finger from the ring finger. The muscle 11 bends the little finger.

The muscles of the LOWER EXTREMITIES may be divided, 1. Into those of the thigh. 2. Those of the leg. 3. Those of the foot.

Fig. 64.

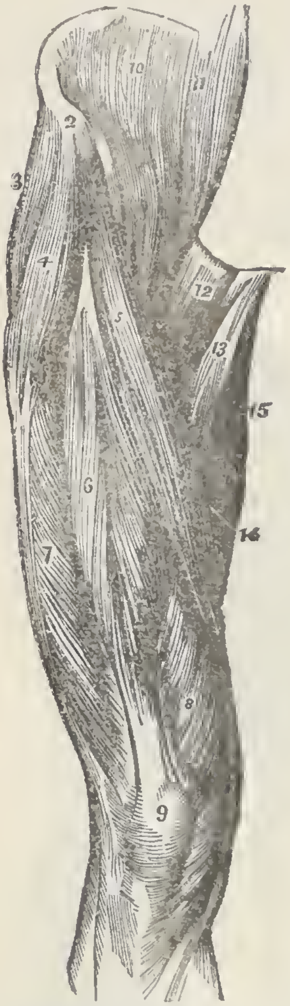


Fig. 65.

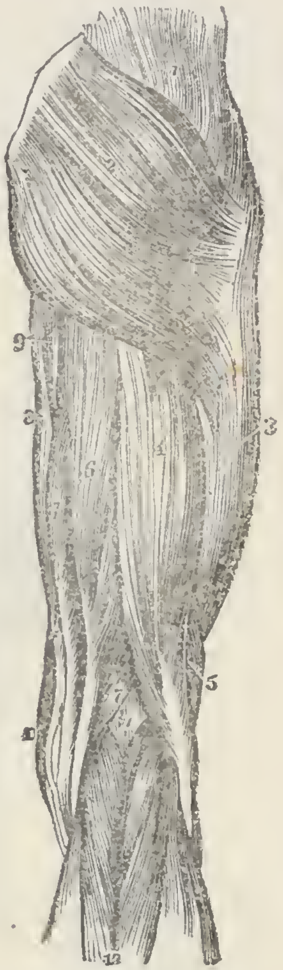


Fig. 64, represents the muscles of the anterior femoral region. 1, The crest of the ilium. 2, Its anterior superior spinous process. 3. The gluteus medius muscle. 4, The tensor femoris; its insertion into the fascia lata is shown inferiorly. 5, The sartorius. 6, The rectus. 7, The vastus externus. 8, The vastus internus. 9, The patella. 10, The iliacus internus. 11, The psoas magnus. 12. The pectineus. 13, The adductor longus. 14, Part of the adductor magnus. 15, The gracilis.

The muscle 5, draws one limb over the other like a tailor when sitting upon his bench. The muscle 6. 7. and 8. extend the leg at the knee. The muscles 10 and 11, bend the thigh at the hip. The muscles 12, 13, and 14, draw one limb towards the other.

Fig. 65, represents the posterior femoral and gluteal region. 1, The gluteus medius muscle. 2, The gluteus maximus. 3, The vastus externus. 4, The long head of the biceps. 5, Its short head. 6, The semitendinosus. 7, The semimembranosus. 8, The gracilus. 9, A part of the inner border of the adductor magnus. 10, The edge of the sartorius. 11, The popliteal space, or ham. 12, The gastrocnemius muscle; its two heads. The tendon of the biceps forms the outer hamstring; and the tendons of the gracilis, semitendinosus and semimembranosus, form the inner hamstring.

The muscles 1, and 2, extend the thigh on the body. The muscles 4, 5, 6, 7, and 8, bend the leg at the knee.

Fig. 66.

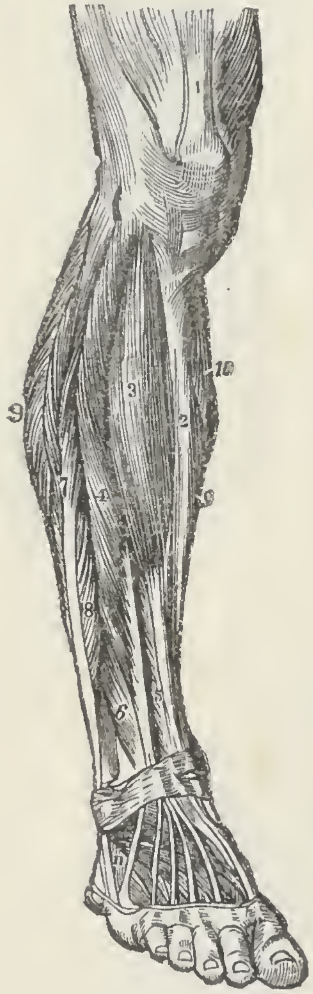


Fig. 67.

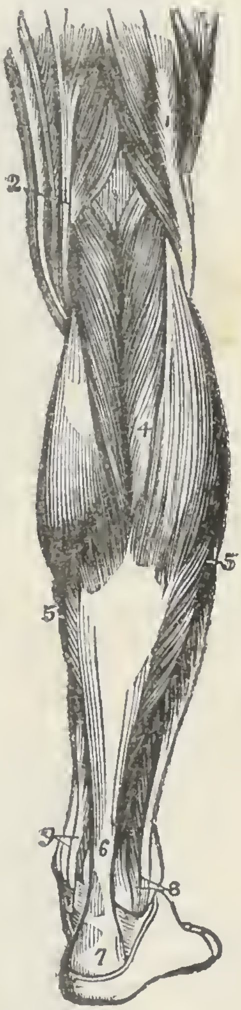


Fig. 66, represents the muscles of the anterior aspect of the leg and foot. 1, The extensor muscles inserted into the patella. 2, The tibia. 3, The tibialis anticus. 4, The extensor communis digitorum. 5, The extensor proprius pollicis. 6, The peroneus tertius. 7, The peroneus longus. 8, The peroneus brevis. 9, 9, Borders of the soleus muscle. 10, A part of the inner belly of the gastrocnemius. 11, The extensor brevis digitorum; the tendon in front of this number is that of the peroneus tertius; and that behind it the tendon of the peroneus brevis. 12, The annular ligament of the ankle, that retains the long tendons in their places.

The muscle 3, bends the foot on the leg at the ankle. The muscles 4, and 11, extend the four small toes. The muscle 5, extends the great toe. The muscles 6, and 7, flex the foot and turn it out.

Fig. 67, represents the superficial muscles of the posterior aspect of the leg. 1, The biceps muscle. 2, The tendons forming the inner hamstring. 3, The poplietal space. 4, The gastrocnemius muscle. 5, 5, The soleus. 6, The tendo Achilles.

The posterior tuberosity of the os calcis. 8, The tendons of the peroneus longus and brevis muscles passing behind the outer ankle.

The muscles 4, 5, 5, extend the foot on the leg at the ankle.

Fig. 68.

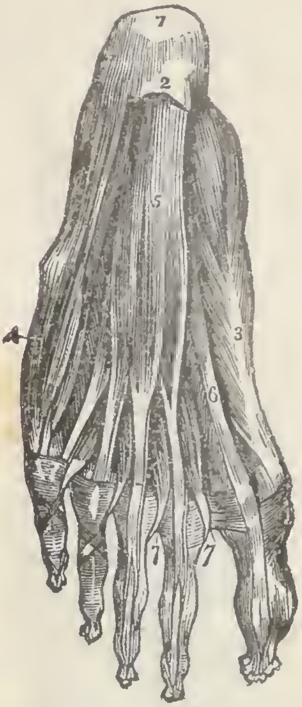


Fig. 69.

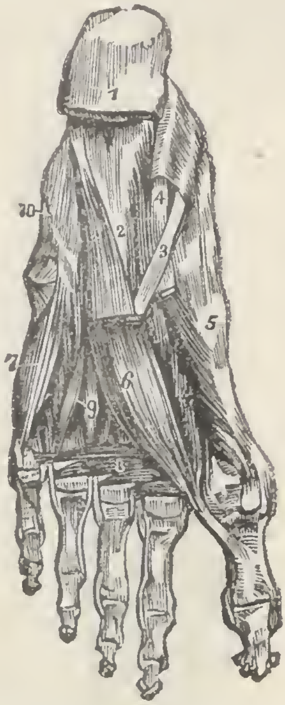


Fig. 68 represents the first layer of muscles in the sole of the foot; this layer is exposed by the removal of the plantar fascia. 1, The os calcis. 2, The posterior part of the plantar fascia divided transversly. 3, The abductor pollicis muscle. 4, The abductor minimi digiti. 5, The flexor brevis digitorum. 6, The tendon of the flexor longus pollicis muscle. 7, 7, The lumbricalis, on the second and third toes, the tendons of the flexor longus digitorum are seen passing through the bifurcation of the tendons of the flexor brevis digitorum.

The muscle 3, separates the great toe from the others. The muscle 4, separates the small toe from the other toes. The muscle 5, bends the four small toes. The muscle 6, flexes the great toe.

Fig. 69, represents the third and part of the second layer of muscles of the sole of the foot. 1, The divided edge of the plantar fascia. 2, The musculus accessorius. 3, The tendon of the flexor longus digitorium muscle, previous to its division. 4, The tendon of the flexor longus pollicis. 5, The flexor brevis pollicis. 6, The adductor pollicis. 7, The flexor brevis minimi digiti. 8, The transversus pedis. 9, Interossei muscles, plantar and dorsal. 10. A convex ridge formed by the tendon of the peroneus longus muscle in its oblique course across the foot.

The muscle 5 bends the great toe. The muscle 6 draws the great toe towards the others. The muscle 7 bends the small toe.

THE FASCIÆ.

Fasciæ are laminæ, or membranes of various extent and thickness, distributed through the different regions of the body, for the purpose of investing and protecting

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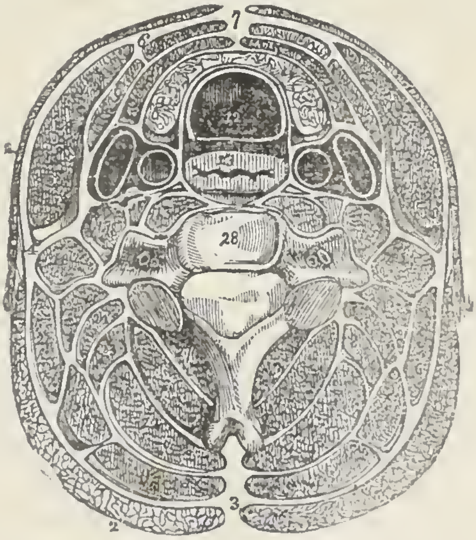
Define *fasciæ*. Where are they distributed? For what purpose?

the softer and more delicate organs. An instance is seen in the membrane which envelopes a leg of beef, and which is observed on the edges of the slices when it is cut for broiling. When freshly exposed, it is brilliant in appearance, tough, and inelastic. In the limbs, it forms distinct sheaths to all the muscles and tendons. It is thick upon the outer and least protected side of the limb, and thinner upon its inner side. It is firmly connected with the bones, and with the prominent parts of each region, as the pelvis, knee, and ankle, in the lower, and the clavicle, scapula, elbow, and wrist, in the upper extremity. It assists the muscles in their action, by keeping up a tonic pressure on their surface. It aids materially in the circulation of the fluids in opposition to the laws of gravity. In the palm of the hand and sole of the foot, it is a powerful protection to the structures that enter into the formation of these regions.

The fasciæ may be arranged into, 1. Those of the head and neck. 2. Those of the trunk. 3. Those of the upper extremity. 4. Those of the lower extremity. In each of these parts of the system, the separate muscles are not only invested by fasciæ, but they are arranged in layers, one over another. The sheath of each muscle is loosely connected to another, by cellular membrane.

Fig. 70.



Mention the different arrangements of the fasciæ.

Fig. 70, represents a transverse section of the neck. The separate muscles, as they are arranged in layers, with their investing fasciæ, are beautifully represented. As the system is symmetrical, figures are placed only on one side.

1, Is the muscle that forms the external layer upon the anterior part of the neck, separated from the second layer of muscles, 5 and 8, by a fascia, represented at 6. The third layer is seen at 9 and 10, separated by a fascia from the second layer, and also from the fourth layer, seen at 11. 12, Is the trachea. 13, Œsophagus. 14, The carotid artery and jugular vein. 2, Is the muscle that constitutes the exterior layer of muscles upon the back part of the neck, separated from the second layer of muscles, seen at 19, 20, 21, by the fascia 3 and 4. The third layer of muscles, 22, 23, 24, 25, is separated from the second layer, by a fascia, and also from the fourth layer, seen at 26. The fifth layer, at 27, separated from the fourth by a fascia, like the other muscles. 28, Is one of the cervical vertebra. In the trunk, the muscles are arranged in layers, surrounded by fascia, as in the neck. The same is true of the muscles of the upper and lower limbs.

PHYSIOLOGY OF THE MUSCULAR SYSTEM.

The peculiar characteristic of muscular fibres is, *contractibility*, or the power of shortening their substance on the application of stimuli, and again relaxing, when the stimulus is withdrawn. This is illustrated in the most common movements of life. Call into action the muscles that elevate the arm, by the stimulus of the *will* or *mind*, (the common stimuli of the muscles,) and the arm and hand are raised. Withdraw this stimulus by a simple effort of the will, and the muscles, before rigid and tense, become relaxed and yielding.

The contractile effect of the muscles, in producing the varied movements of the system, may be seen in the bending of the elbow. The tendon of one extremity of the muscle is attached to the shoulder bone, which acts as a fixed point; the tendon of the other extremity is attached to one of the bones of the fore-arm. When the belly of the muscle contracts, or shortens, its two extremities approach nearer each other; and by the approximation of the terminal extremities of the muscle the bones at the elbow bend. On this principle, all the joints of the system are moved. This is illustrated in fig. 71.

When the fibres of a muscle contract while the two extremities are brought nearer each other, the contracted part of it, or belly, becomes fuller and harder.

The muscles exercise great influence upon the system. It is by their contraction that we are enabled to pursue different employments. By their action, the farmer cultivates his field, the mechanic wields his tools, the author

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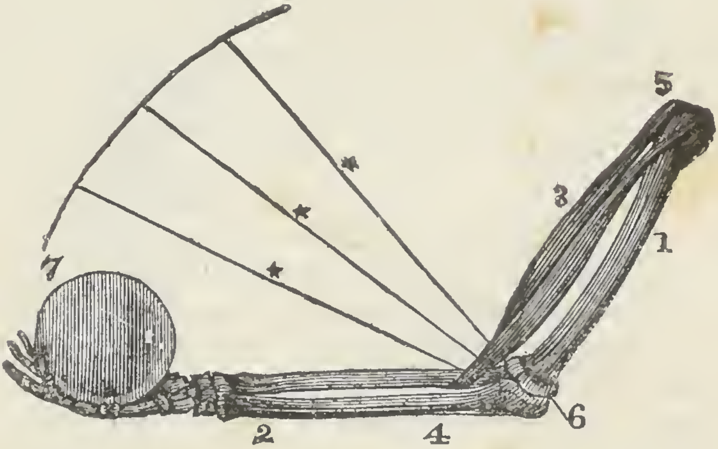
What does fig. 70 represent? How are the muscles invested? How are they arranged in regard to each other? What is the peculiar characteristic of muscular fibres? Describe how the elbow is bent?

drives his quill, the sportsman pursues his game, the orator gives utterance to his thoughts, the lady sweeps the keys of the piano, and the young are whirled in the mazy dance. As such is the relation the muscles bear to the pleasures and employments of man, so a knowledge of the laws, by which their action is governed, and the conditions upon which their health depends, should be possessed by all.

Fig. 71.



1, Is the humerus, or first bone of the arm. 2, One of the bones of the fore arm, to which the muscle (3) that bends the elbow, is attached at 4. 5, The attachment of this muscle to the humerus, at its upper extremity. 6, The elbow joint. 7. A weight in the hand, to be elevated by the contraction of the muscle seen at (3;) as the bones of the fore arm (2) are brought to the lines indicated by * * * the belly of the muscle (3) contracts, and its two ends are brought nearer together.

PRACTICAL SUGGESTIONS.

In order that the size of muscles may be adequate to the power demanded of them, it is necessary that—1st. *The muscles should be used, alternated with rest.* It is a law of the system that the action and power of an organ are commensurate, to a certain extent, with the demand made upon it, and, it is a law of nature that whenever a muscle is called into frequent use, its fibres increase in thickness, within certain limits, and become capable of acting with greater force. While, on the contrary, the muscle that is little used decreases in size and power.

By the agency of what part of the system is every movement effected? Why is it important that every individual should know the laws on which the health of the muscles depends? What is the first condition?

The reason why action increases the size of muscles, is obvious, when we recollect that arterial blood is supplied to every organ of the system, in proportion to the extent and energy of its action. On the other hand, when an organ is not duly supplied with nutrient blood, it becomes enfeebled, and gradually loses its power of action. Compare the arm of the smith who works at the anvil, with the limb that has been supported in a sling—the arm of the one will be found large and firm, while that of the other is small and soft. In the one, the action of the vessels is energetic; in the other sluggish.

Let the inactive boy and girl, or gentleman and lady, remember this, when complaining of want of strength, loss of appetite, depressed spirits; when they are seeking some sovereign remedy for their complaints—apparently unmindful that God, in his infinite benevolence, has adapted the bones and muscles to action.

2nd. *The muscles should not be compressed.* Compression prevents the blood from passing to these parts with freedom; consequently, they are not supplied with material to renovate them or promote their growth. Again, pressure stimulates the absorbents to action. By the increased activity of these vessels, the muscles are attenuated. In the case of a man with a fractured limb, the muscles are not only enfeebled by inaction, but diminished in size, by compression from the dressing. Limbs enfeebled in this way, will not recover their size, tone, and strength, until the bandages have been removed, and a proper amount of exercise has been taken. The pressure of tight dresses, under the name of a 'snug fit,' enfeebles the muscles of the back, and is a prolific cause of projecting shoulders, and curvatures of the spine.

3d. *Muscles should be abundantly supplied with pure blood.* The following conditions are essential to this state of the blood, viz., a healthy state of the digestive organs, a proper quantity and proper quality of food, taken at due intervals, and when the system is in a condition to

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Why does action increase the size of muscles? What comparison is made? What advice is given to those of indolent habits? What is the second condition? Why is compression of a muscle injurious? What is another reason for muscles becoming attenuated? What is a prolific cause of projecting shoulders and curved spines? What is the third condition?

digest aliment. *(See Chap. on Digestive Organs.)* Purity of blood also requires attention to the skin. It should be kept warm by proper clothing, clean by bathing, and be acted upon by pure air and good light. *(See Chap. on the Skin.)* As the blood is oxydated and divested of a portion of impurity in the lungs, they should have ample volume, possess good health, and be supplied with pure air. The movements of the ribs and diaphragm should be unrestricted. *(See Chap. on the Lungs.)*

Fig. 72.

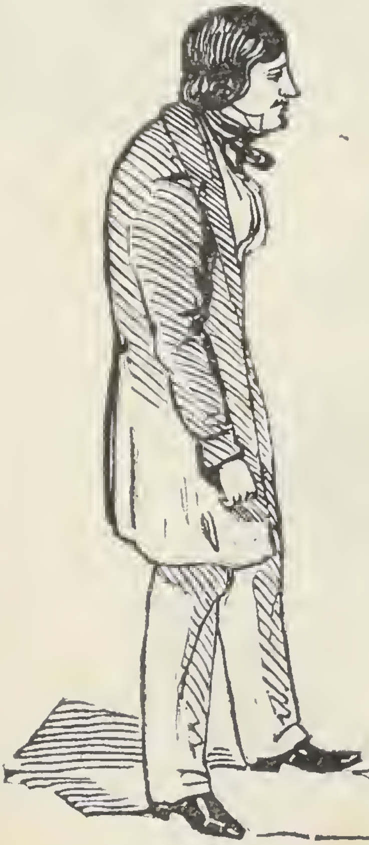
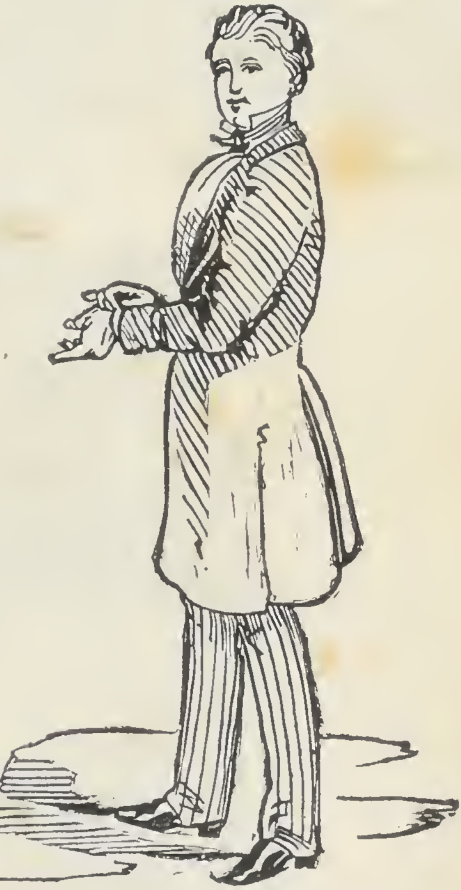


Fig. 73.



In fig. 73, the erect and correct position for standing or walking is represented. In fig. 72, the stooping and deformed position is illustrated. This deformity can be corrected if the youth will frequently practise throwing the shoulders back, and walk, as well as stand erect. Pupils while standing during recitations, often inadvertently assume the leaning attitude, and it is the duty of teachers to correct this position when assumed.

In all instances, muscular power is greatest when the foregoing conditions exist; consequently, it is of practical

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When is muscular power greatest?

importance to the laboring mechanic, the industrious agriculturist, the man of leisure, and not less so to the ladies, whatever avocation of life they pursue, to observe them.

4. The attitudes of children in standing and sitting have been much neglected, both by parents and teachers. Let the stooping posture be acquired in youth, and we are quite certain of seeing the stooping shoulder in old age. Hence, the importance of duly exercising the muscles of the back; for, when they are properly developed, the child can stand or sit erect. In this attitude the shoulders will be thrown back, and the chest will become broad and full. But on the contrary, let the youth acquire the habit of inclining his head and shoulders, and the chest will become contracted, the muscles of the back enfeebled, and the deformity thus acquired, will progress to advanced age.

Fig. 71.

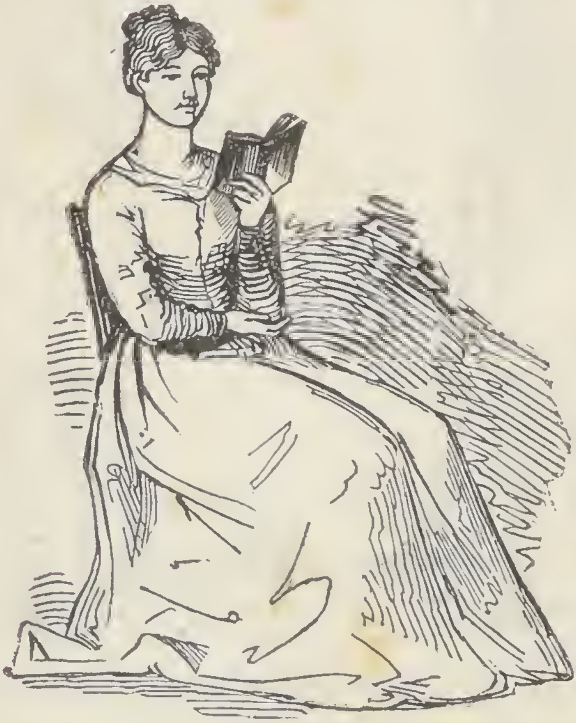


Fig. 74, represents the proper and physiological position in sitting.

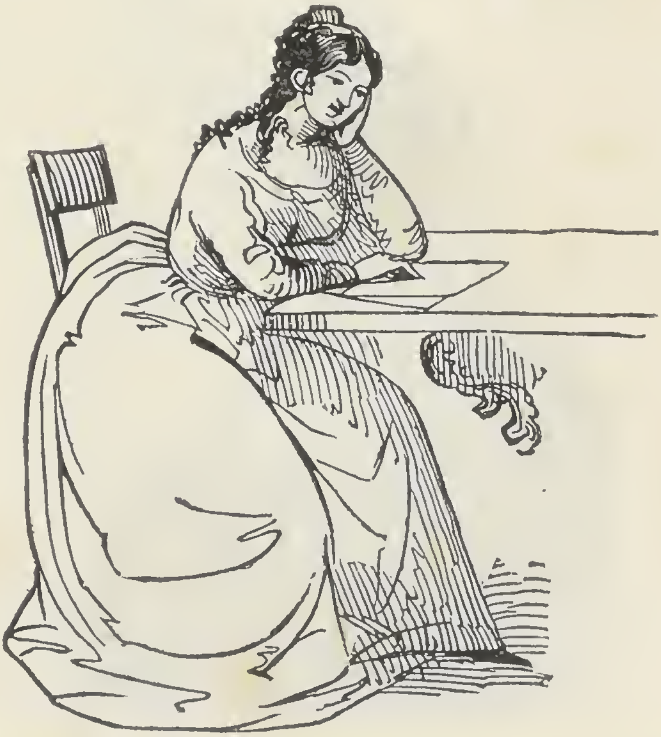
The position of a child or an adult, when sitting, conduces to a healthy or unhealthy condition of the system.

Have the attitudes of children been neglected? What directions are given to acquire a good form? The design of Figs. 72, 73—and what duty is imposed upon teachers in this section?

The child should be taught to sit erect, when employed in study or work, as this attitude favors a healthy action of the various organs of the system.

Scholars are more or less inclined to lean forward and place the elbow on the table or desk for support; and this is often done when their seats are provided with backs. Where there is a predisposition to a curvature of the spine, no position is more unfavorable, or more productive of deformities than this, for, it is usually continued in one direction, and the apparent deformity it induces, is a projection of the shoulders. If the girl is so feeble that she cannot sit erect, as represented in fig. 74, let her stand, or recline on a couch; either is preferable to the position represented in fig. 75.

Fig. 75.

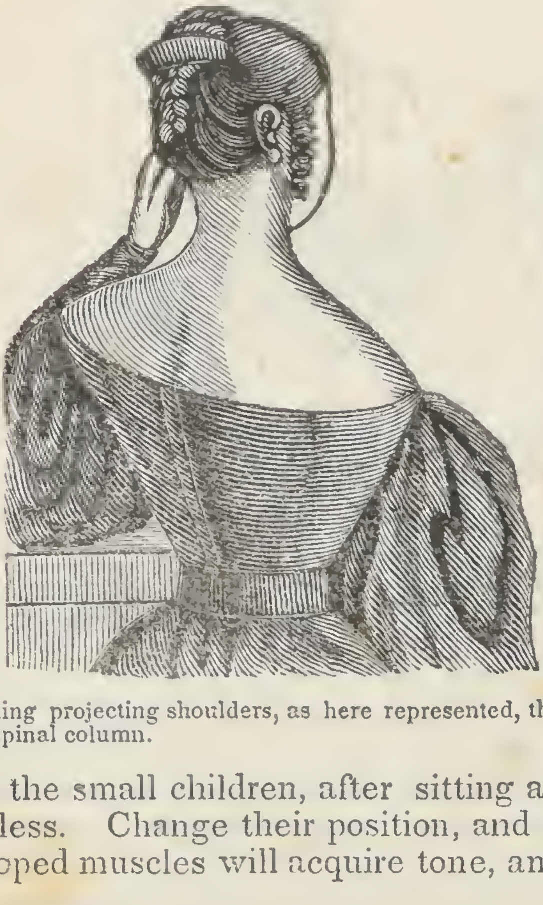


In furnishing school-rooms, care should be taken that the seats for the scholars are provided with appropriate backs, and the desks should not be so low as to compel them to lean forward in examining their books.

Why should a child sit erect? What is the effect of the leaning attitude? If the child is so feeble that she is unable to sit erect, what attitudes are preferable?

5th. *Relaxation must follow contraction, or in other words, rest must follow exercise. This is a fundamental law of the muscular system.* The necessity of relaxation, when a muscle has been called into action, is seen in the example of a boy extending his arm, with a book in the hand, as a punishment. The boy can keep the arm extended but a little time, make what effort he may. It is also seen in the restlessness and feverish excitement that are evinced by persons gazing on troops during days of review. The same is noted in shopping. Such employments call into action the muscles that support the spinal column in an erect position. This languor, or uneasiness, is muscular pain. The long-continued tension and stretching of a muscle enfeeble its action, and eventually destroy its contraction.

Fig. 76.



In cases exhibiting projecting shoulders, as here represented, there is uniformly curvature of the spinal column.

In school, the small children, after sitting a short time, become restless. Change their position, and their imperfectly-developed muscles will acquire tone, and will again

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What is a fundamental law of the muscular system? Give examples of the necessity of relaxing the muscles?

support the spinal column erect without pain. Compelling children to sit erect, for a *long time*, is an evil practice; for it is a violation of the muscular law, and too frequently produces the lateral curvature of the spine, and projecting shoulder.

The necessity of frequent intermissions or recesses in school, is founded on the organic law of muscular action, alternating with rest.

Fig. 77.

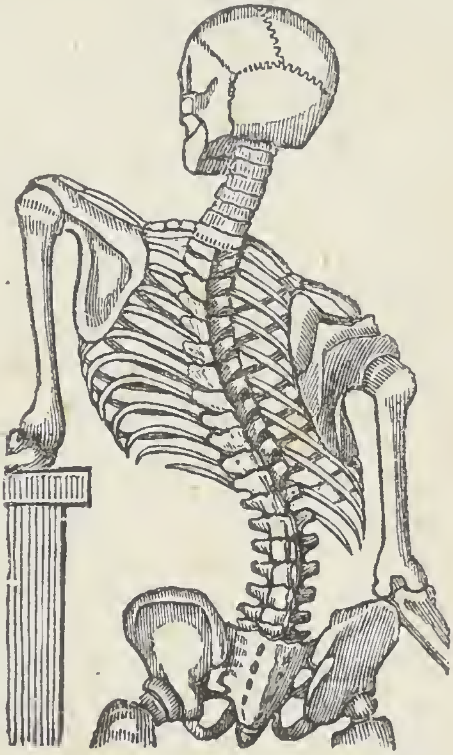

Fig. 77 represents the condition of the spine, or back bone, where projections of the shoulders are seen, or where one shoulder projects. In such cases, there is always a lateral curve of the spinal column; usually there are two, as seen above.

The ribs at the lower part of the chest hollow in, and on the other side they project. One hip likewise projects.

The younger and more feeble pupils are, the greater is the necessity for frequent recesses. We would not have the teacher think, that one half of her time, at least, should be spent in giving her pupils intermissions; or the mother, that her daughter is going to school to play. But

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Why should not small children be confined in one position for a long time? What evils result from this practice? What class of pupils should have recesses most frequently?

we maintain that recesses should be given; and let them be short and frequent for small and feeble scholars. If such were the practice, young misses would not complain of weakness in the spine and limbs, and of a dislike for school.

Exhaustion is the inevitable result of continued tension and muscular contraction. For example; let a lady ply the needle quickly for some hours—the muscles of the back and right arm become exhausted, which is indicated by a sense of weariness in these parts. A change of employment and position calls into action a different set of muscles, and relieves the exhausted organs. Much more labor will be accomplished by taking time to relax the exhausted muscles. This is true, also, of the horse and ox; and it is applicable to all kinds of employment. A disregard of the law of the muscles, is attended with weighty consequences. With the invalid convalescing from fever, relapses result from such a course of action. When a patient is recovering from sickness, his physician should take care that his exercise be proper—neither too much, too little, nor too long continued.

6th. Every fibre of each muscle is connected with the brain, by white cords, that pass from its base and the spinal cord. Through the agency of these cords, called *nerves*, the brain imparts to the muscles a nervous fluid, that induces contraction or action in them. Consequently, *the health, activity, and size of the brain, spinal cord, and nerves, modify muscular action.* If the brain be healthy, muscular action will be more efficient than if it be diseased. This is illustrated by the muscular prostration observed in typhus fever, apoplexy, inflammation of the brain, and intoxication. The cessation of the action of the muscles, while the brain is inactive, illustrates the influence that the nervous system exerts upon muscular energy. If the spinal cord, or the nerves distributed to any set of muscles, be destroyed, their contractility and sensibility will cease. Compression of the nerves, in any

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What effect has the continued tension of a muscle? Give an example from the exhaustion of muscles. What is one cause of relapse of fever? Is every fibre of each muscle connected with the brain? What is the medium of this connection? What modifies muscular action? Give examples in which muscular action will be inefficient. What effect has compression on the nerves?

member of the system, destroys or impairs its sensibility or movements. The want of sensibility, and the diminished strength of the lower limbs, sometimes experienced after sitting upon a hard bench, are illustrations of the effects of compression of the nerves. In this instance the sciatic nerve, distributed to the leg, is compressed.

It has been observed among men of the same size, that a wide difference exists in their muscular strength and activity. This depends upon the size and number of the nerves, and the size and activity of the brain. Men having large nerves leading to the muscles, with the brain active, will perform feats of strength and agility, that other men, of the same size, cannot effect. Rope dancers, harlequins, and other performers of feats, are persons thus constituted. Persons with small muscles, and largely developed nervous system, will sometimes exhibit very great muscular power for a time, but it will not be of long continuance, except the brain is functionally diseased, as in hysteria. Men of large muscles and small nerves, can never perform feats of great strength, but they have the power of endurance, and are better capacitated for continued labor. Thus we cannot judge of the ability of a person to make exertions and continue them, by their stature alone. Strength, and the power of endurance, are the result of the combination of well-developed muscles, large nerves, and a full-sized, healthy, and active brain.

7th. The mind exerts a great influence upon the tone and contractile energy of the muscular system. A person acting under a healthy mental stimulus, will make exertion with less fatigue than he would without this incentive. For an illustration, a sportsman will pursue his game miles without fatigue, while his attendant, not having any mental stimulus, will become weary. Again, let him spend some hours in pursuit of his favorite game without success—a feeling of languor creeps over him; but

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Give an example. On what does the difference of muscular activity and strength depend? What is said of those persons who have small muscles, and largely developed nervous systems? Of those who have large muscles, and small nerves? Upon what do strength and the power of endurance depend? Does the mind have any influence upon muscular contractility? Give an illustration of mental stimulus coöperating with muscular activity in the case of a sportsman.

while thus fatigued and dispirited, let him catch a glimpse of the game—his wearied feelings are immediately dissipated, and he presses on with renewed energy and recruited strength.

This principle was well illustrated in the defeated and dispirited French army, in their retreat from Russia. When no enemy was near, they had hardly strength sufficient to carry their arms; but no sooner did they hear the report of the Russian guns, than new life seemed to pervade them, and they wielded their weapons powerfully, until the foe was repulsed; then there was a relapse to weakness, and prostration followed. It is thus with the invalid when riding for his health,—relate an anecdote, or excite this mental stimulus by agreeable conversation, and much benefit will accrue from the ride to the debilitated person. So it is in the daily avocations of life; if the mind have some incentive, the tiresomeness of labor will be greatly diminished. Let an air of cheerfulness ever pervade our every employment, and, like music, 'it sweetens toil.'

Facts illustrative of the inutility of calling the muscles into action, without the coöperation of the mind, are seen in the spiritless aspect of many of our boarding school processions; when a walk is taken merely for exercise, without having in view an attainable object. But present to the mind a botanical or geological excursion, and the saunter will be exchanged for the elastic step,—the inanimate appearance, for the bright eye and glowing cheek. The difference is simply, that in the former case, the muscles are obliged to work without that full nervous impulse so essential to their energetic action; and that, in the latter, the nervous impulse is in full and harmonious operation.

It must not, however, be supposed that a walk simply for the sake of exercise can never be beneficial. If a person be thoroughly satisfied that exercise is requisite, and is *willing*, or desirous, to obey the call which demands

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Give an illustration of mental stimulus coöperating with muscular activity in the case of the dispirited French army, in their retreat from Russia. Can a union of mental impulse and muscular action be beneficial to an invalid? How? Does the same principle apply to those who labor? Give an instance of the different effects produced by the absence and presence of the mental stimulus.

it, he is from that very circumstance, in a state to derive benefit from it; because the *desire* then becomes a sufficient nervous impulse, and one in perfect harmony with the muscular action. It is when persons are dragged out against their inclinations, that walking is comparatively useless.

'The advantages of combining harmonious mental excitement with muscular activity, have not escaped the sagacity of the late Dr. Armstrong, who thus notices them in his frequently-reprinted Poem on the Art of Preserving Health, but without giving the physiological explanation:'

'*In whate'er you sweat,*
Indulge your taste. Some love the manly toils,
The tennis some, and some the graceful dance;
Others, more hardy, range the purple heath
Or naked stubble, where, from field to field
The sounding covies urge their lab'ring flight,
Eager amid the rising cloud to pour
The gun's unerring thunder; and there are
Whom still the mead of the green archer charms.
He chooses best whose labor entertains
His vacant fancy most; THE TOIL YOU HATE
FATIGUES YOU SOON, AND SCARCE IMPROVES YOUR LIMBS.'

8*th*. *Upon the training or education of the muscles*, in a measure, depends the power of giving different intonations in reading, speaking, and singing, the varied and rapid executions in penmanship, and all mechanical and agricultural employments. It is by having control over this part of the system, that efficiency is attained in any art. As muscular contraction is effected by a stimulus from the brain through the agency of the nerves, to produce this steady and effective contraction of the fibres, these organs, viz: the brain and nerves, should be healthy. In the first effort of muscular education, the contraction of the muscular fibres is irregular and feeble, as seen when the child begins to walk, or in the first efforts at penmanship. Repeated efforts render the muscular contraction obedient to the will. Thus, in learning any trade, let the work be

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How is the power of giving different intonations in reading and speaking, effected? Through the action of what agency is every mechanical movement made? When a child begins to walk, why are its steps so irregular? What is said of learning a trade?

done as correctly as possible, at the first trial, and, by practice, the muscles will act readily and harmoniously, in obedience to the mental stimulus. By training all the muscles of the system, they will act in unison and harmony, to produce a given result. In mowing, certain muscles of the trunk, and of the upper and lower extremities, are called into action. The boy's first trial is tedious and awkward, from calling into requisition muscles unaccustomed to the exigency. Let this be repeated, and harmony of action will soon be attained.

In writing, two things are necessary, viz: To acquire the form of the letters, and the power of making them. The first is attained by the inspection of the letter. The second is attained by calling into action the muscles of the arm, wrist, and fingers. Before the boy can make letters of a given form, the muscles, to effect this purpose, must be educated to contract and relax steadily and harmoniously. In order to train the muscles in mowing, dancing, playing the piano, writing, or anything else, they must be relaxed, so as to be at the command of the will; stiff and constrained attitudes will not promote the object. With the pencil upon the slate, the boy will make smooth, graceful lines. Put a pen into the hand of a beginner in writing, and tell him to hold it in a certain position, and place the paper in a particular manner, and he will grasp the pen with great vigor,—the muscles of the arm, wrist, and hand will be rigid,—the movements will be cramped and irregular. The pencil being held differently, the lines upon the slate will be smooth and graceful. The different results, in the two cases, arise from the different condition of the muscles. If the pen were held as easily, and grasped no more firmly than the pencil, the movements would be as easy, and the result as satisfactory. Before trying to make any particular letter, let the boy scribble, making marks with rapidity, in any way, as he does with the pencil upon the slate. By so doing a free hand-writing will be acquired.

How many things are necessary in writing? What are they? How attained? How can easy and elegant penmanship be acquired?

CHAPTER VI.

THE DIGESTIVE ORGANS.

The abdomen is the inferior or lower cavity of the trunk of the body. It is bounded in front and at the sides by the lower ribs and abdominal muscles; behind, by the vertebral column and abdominal muscles; above, by the diaphragm; and below, by the pelvis. It contains the organs subservient to digestion,—viz: the stomach, the intestines, the liver, the pancreas, the spleen, and the organs of excretion.

For convenience of description of the viscera, and for reference to the morbid affections of this cavity, the abdomen is divided into certain districts or regions. Thus, if two transverse lines be carried around the body, the one parallel with the convexities of the ribs, the other with the highest points of the crests of the ilia, the abdomen will be divided into three zones. Again, if a perpendicular line be drawn at each side, from the cartilage of the eighth rib to the middle of Poupart's ligament, the three primary zones will each be subdivided into three compartments or regions—a middle, and two lateral.

ANATOMY OF THE DIGESTIVE ORGANS.

The digestive organs are divided into the *jaws, salivary glands, mouth, pharynx, œsophagus, stomach, small and large intestines, lacteals, thoracic duct, liver, spleen and pancreas.*

The JAWS have been described in the chapter upon the bones, (page 52.)

The SALIVARY GLANDS are six in number; three on

How is the abdomen bounded? What does it contain? Name the organs that aid the process of digestion. Name the *salivary glands.*

each side. They are named the *parotid*, the *submaxillary*, and the *sublingual.*

The parotid gland, the largest, is situated in front of the external ear, and behind the ramus of the jaw. A duct from this gland, named Steno's, opens into the mouth, opposite the second molar tooth of the upper jaw.

The submaxillary gland is situated within the lower jaw, anterior to the angle. Its excretory duct, (*Wharton's,*) opens into the mouth by the side of the frænum or bridle of the tongue.

Fig. 78.

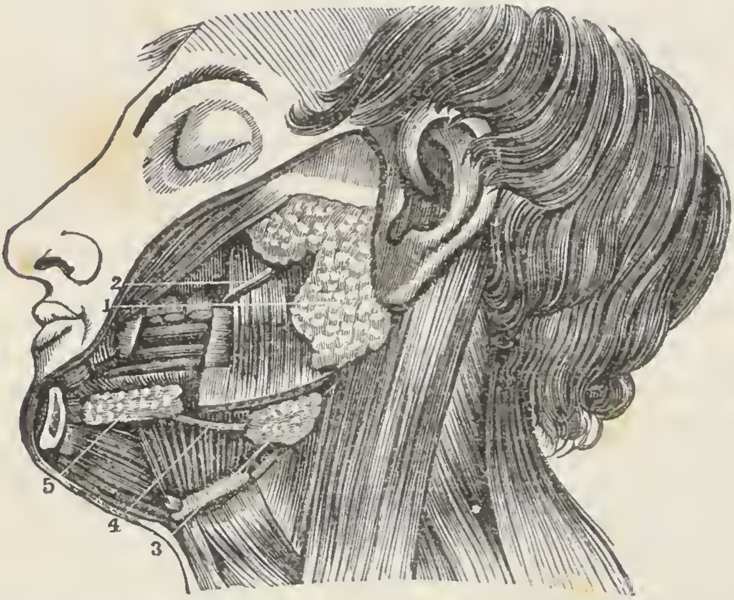

Fig. 78 is a view of the salivary glands in their proper situations. 1, The parotid gland. 2, The duct of Steno. 3, The submaxillary gland. 4, Its duct. 5, The sublingual gland.

The sublingual gland is elongated and flattened, and situated beneath the mucous membrane of the floor of the mouth, on each side of the frænum linguæ. It has seven or eight small ducts, which open into the mouth, by the side of the bridle of the tongue.

The MOUTH is an irregular cavity, which contains the instruments of mastication, and organs of taste. It is bounded in front by the lips; on each side, by the inter-

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Describe the parotid gland. Where is the submaxillary gland situated? What does Fig. 78 exhibit? Describe the sublingual gland and its situation. How many ducts has it, and where do they open? Describe the *mouth.*

nal surface of the cheeks; above, by the hard palate, and teeth of the upper jaw; below, by the tongue and teeth of the lower jaw; behind, by the soft palate and fauces.

Fig. 79.

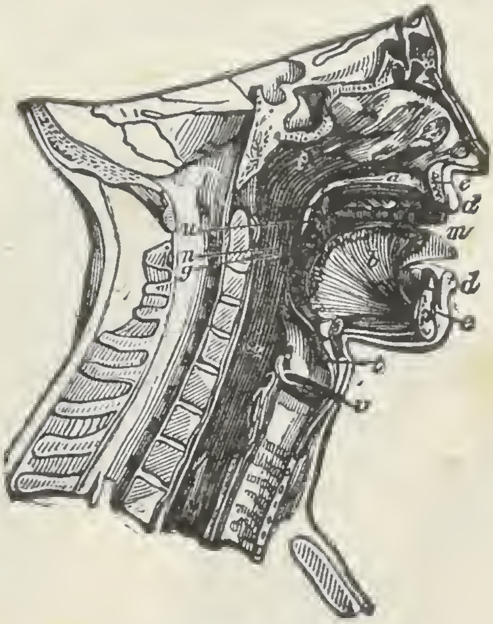

Fig. 79 represents an antero-posterior section of the mouth, tongue, pharynx, œsophagus, trachea, and cervical portion of the spinal column.

a, Is the palate bone, or roof of the mouth; *b*, genio glossus muscle; *m*, the tongue; *d*, *d*, upper and lower lips; *e*, *e*, upper and lower jaw; *u*, the soft palate; *n*, the opening of the pharynx into the mouth; *t*, epiglottis; *v*, vocal cords; 2, the commencement of the œsophagus; 1, opening of the eustachian tube; *y*, the œsophagus.

The PHARYNX, from the Greek, *pharugx*, (the swallow,) is a muscular membranous sac, situated upon the cervical portion of the vertebral column. It extends from the base of the skull to the top of the trachea, or wind-pipe. It is composed of muscular and mucous membranes, blood vessels and nerves. The posterior nares, or nostrils, open into the upper and front part of the pharynx. Beneath the posterior nares, partly veiled by the soft palate, is a large opening into the mouth; and beneath the root of the tongue, the opening into the larynx. The pharynx terminates in the œsophagus.

The ŒSOPHAGUS, from the Greek, *oiô*, I carry, and *phagô*, I eat, is a flexuous canal that commences at the fifth cer-

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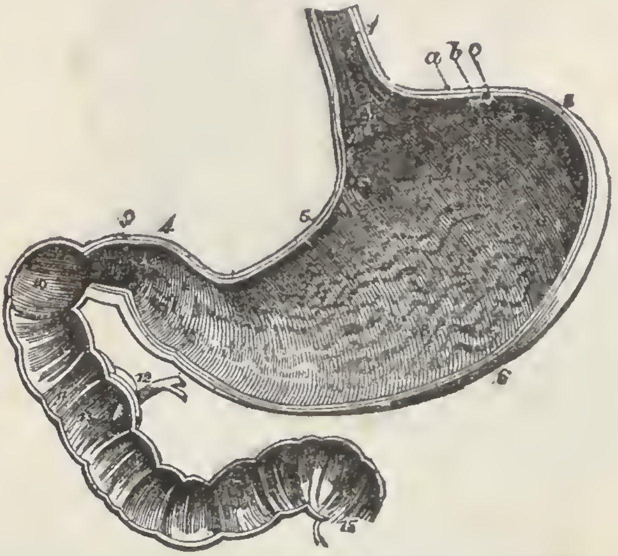
Describe Fig. 79. Describe the *pharynx*. Of what is it composed? What is said of its anterior part? Its posterior? Where does the pharynx terminate? Describe the *œsophagus*.

vical vertebra, behind the cricoid cartilage. It descends the neck between the trachea and cervical vertebræ. In the thorax it lies before the thoracic aorta. It passes through the diaphragm, and terminates at the cardiac orifice of the stomach. It is composed of three coats, and is supplied with arteries, veins and nerves.

Fig. 80.



A vertical and longitudinal section of the stomach and duodenum, made in such a direction as to include the two orifices of the stomach. 1, The œsophagus, upon the internal surface of which, the follicated arrangement of the cuticular epithelium is shown. 2, Cardiac orifice of the stomach, around which the fringed border of the cuticular epithelium is seen. 3, The great end of the stomach. 4, Its lesser or pyloric end. 5, The lesser curve. 6, The greater curve. 7, The dilatation at the lesser end of the stomach. This may be regarded as the rudiment of a second stomach. 8, Rugæ, lying in a longitudinal direction, formed by the mucous membrane. 9, The pylorus. 10, Oblique portion of the duodenum. 11, Descending portion. 12, The pancreatic duct, and the ductus choledochus, close to their termination. 13, Papilla, upon which the ducts open. 14, Transverse portion of the duodenum. 15, Commencement of the jejunum. In the interior of the duodenum and jejunum, the valvulæ conniventes are seen. *a*, the external coat; *b*, the middle coat; *c*, the inner coat.

The STOMACH is situated in the left side, immediately below and in contact with the diaphragm. Its small extremity extends into the epigastric region, below the left lobe of the liver. It has two curvatures, the great and the small; and two openings; one connected with the œsophagus, named the cardiac orifice; the other connected with

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How many coats or membranes enter into the composition of the œsophagus? Describe Fig. 80. Where is the *stomach* situated? How many curvatures? How many orifices? Where is the cardiac orifice? The pyloric?

the duodenum, named the pylorus, or pyloric orifice. In shape, it is curved, like the Scotch bagpipe. It is composed of three coats, or membranes; the exterior coat, named the serous, which is a part of the peritoneum; the middle coat, named the muscular, composed of two layers of muscular fibres, one set of which is arranged longitudinally, and the other circularly. The interior coat is named the mucous, and is arranged in rugæ, or folds. In this membrane are seen follicles, in which the mucus that protects the membrane, is secreted. The stomach is provided with a multitude of minute glands, in which is secreted the gastric fluid, or solvent.

Fig. 81.

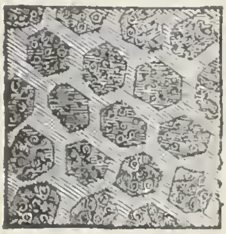

Fig. 82.

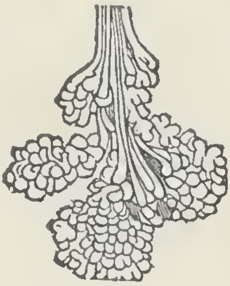

Fig. 83.

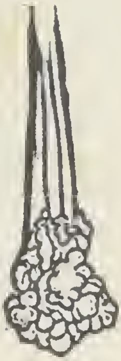

Fig. 81 represents a portion of the mucous membrane of the stomach, showing the entrances of the secreting tubes, or follicles, upon its surface.

Figs. 82 and 83, represent glands from different sections of the stomach, from which gastric juice is secreted. They are magnified 45 diameters.

The small intestines, are about twenty-five feet in length, and are divisible into three portions,—*duodenum*, *jejunum*, and *ileum*.

The DUODENUM is somewhat larger than the rest of the small intestines, and has received its name from being, in length, about the breadth of twelve fingers. It commences at the pylorus, and ascends, obliquely, backward, to the under surface of the liver. It then descends perpendicularly in front of the right kidney, and passes transversely across the third lumbar vertebra, and terminates in the jejunum. The ductus choledochus communis, and

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What is the form of the stomach? How many membranes has it? Describe each coat or membrane. Where is the mucus secreted? What other secretion in this organ? What do Figs. 81, 82, and 83 represent? What is the length of the small intestines? How divided? What is said in regard to the *duodenum?* Give the situation of the duodenum. Where do the pancreatic and choledochus ducts open?

pancreatic duct, open into the perpendicular portion, a little below its middle.

The JEJUNUM forms the upper two-fifths of the small intestines. It commences in the duodenum, and terminates in the ileum. It is thicker than the rest of the intestines, and has a pinkish tinge.

The ILEUM includes the remaining three-fifths of the small intestine. It is somewhat paler, smaller in caliber, and thinner in texture, than the jejunum. There is no mark to distinguish the termination of the one, or the commencement of the other. The ileum terminates in the right iliac fossa, by opening into the colon, at an obtuse angle. This opening is called the ilio colic valve, as it prevents the passing of substances from the colon into the ileum. The jejunum and ileum are surrounded above and at the sides, by the colon.

The small intestines have three membranes or coats; the outer or serous; the middle, or muscular; and the internal, or mucous coat. This last is thrown into folds, or valves, named the *valvulæ conniventes.* In consequence of this valvular arrangement, the mucous membrane is more extensive than the other tissues; and gives a greater extent of surface with which the aliment comes in contact.

Fig. 84.

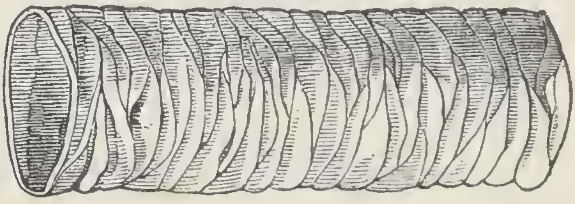

Fig. 85 represents the valvulæ conniventes of the internal surface of the small intestines.

There are embedded under the mucous membrane, an immense number of minute glands, named the glands of Peyer and Brunner. There are, likewise, upon the mucous coat, an immense number of piles, like those upon velvet; hence this membrane is named the villous coat.

What is said of the *jejunum*? Its color? What of the *ileum*? Can the precise termination of each be distinguished? By what are they surrounded? How many coats or membranes have the small intestines? How is the *valvulæ conniventes* formed?

Fig. 85.

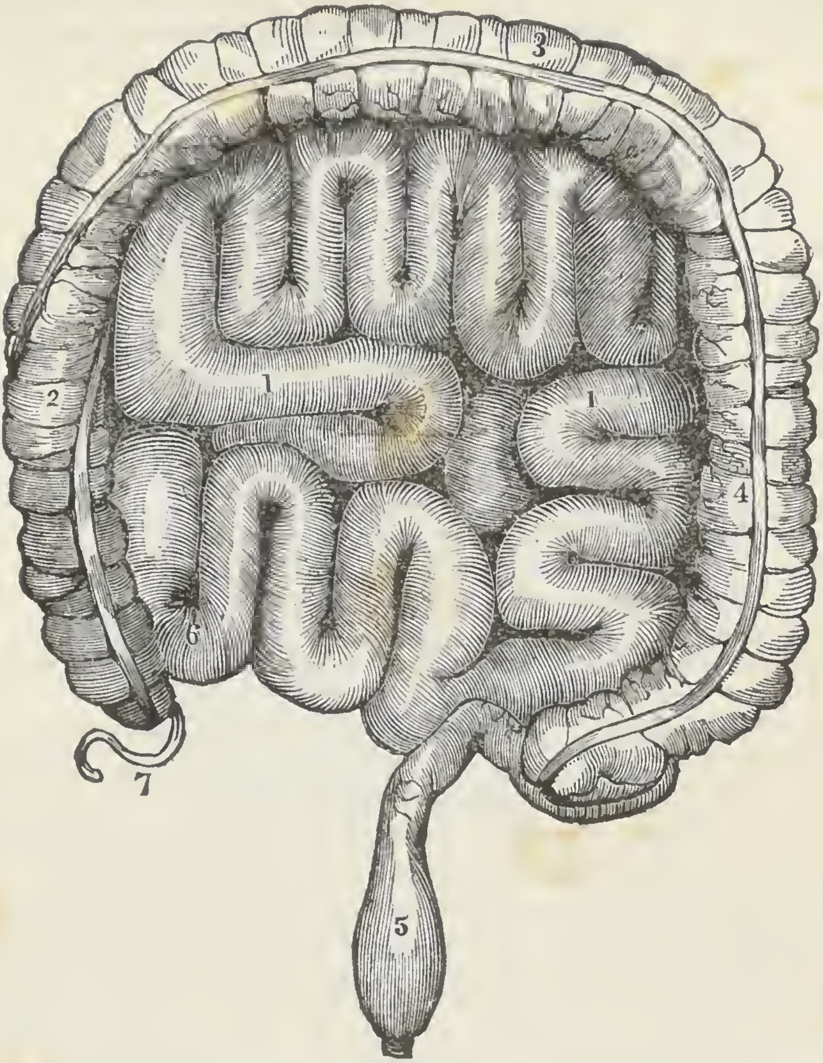

Fig. 85. 1, 1, The small intestines. 2, The ascending colon. 3, The transverse colon. 4, The descending colon. 5, The rectum. 6, The junction of the small with the large intestines. 7, The appendix vermiformis.

The LACTEALS are minute vessels, which commence in the *villi*, upon the mucous surface of the small intestines. From the intestines, they pass between the laminæ of the mesentery, to small glands, which they enter. The first range of glands collect many small vessels, and transmit a few larger branches to a second range of glands. From the second range, the lacteals, diminished

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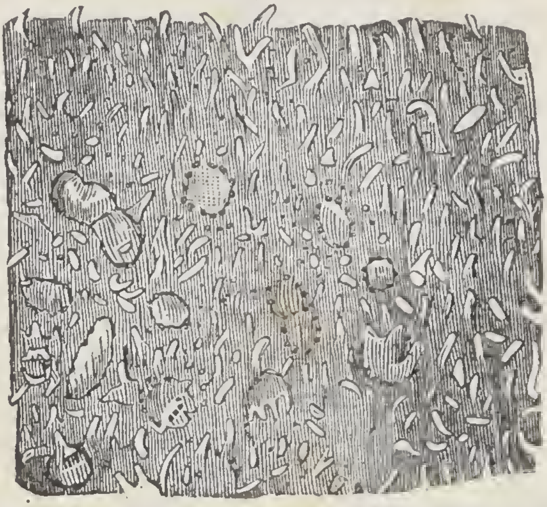
What are the *lacteals*? What is said of the first range of glands? Of the second?

in number, and increased in size, proceed to the enlarged portion of the thoracic duct, named the *receptaculum chyli*, into which they open.

Fig. 86.



This engraving represents the small glands of the intestines, that lie under the mucous coat. They are represented highly magnified. The villi are also displayed.

The THORACIC DUCT commences in the abdomen, by a considerable dilatation, named the *receptaculum chyli*, which is situated upon the front of the body of the second lumbar vertebra. From this point, it passes through the diaphragm, and ascends to the fourth dorsal vertebra. It there lies anterior to the spine, and by the side of the aorta. It then inclines to the left, behind the arch of the aorta, and ascends by the side of the œsophagus, to the seventh cervical vertebra, where it makes a sudden turn downward and forward, and terminates by opening into the vein at the junction of the left subclavian, and left internal jugular vein. The thoracic duct is equal in diameter to a goose-quill, and, at its termination, is provided with a pair of semilunar valves, which prevent the admission of venous blood into its cylinder.

The large intestine, about five feet in length, is sacculated in appearance, and divided into the *cœcum*, *colon*, and *rectum*.

The CŒCUM is the blind pouch, or cul-de-sac, at the commencement of the large intestine. Attached to its extremity is the *appendix vermiformis*, a long, worm-

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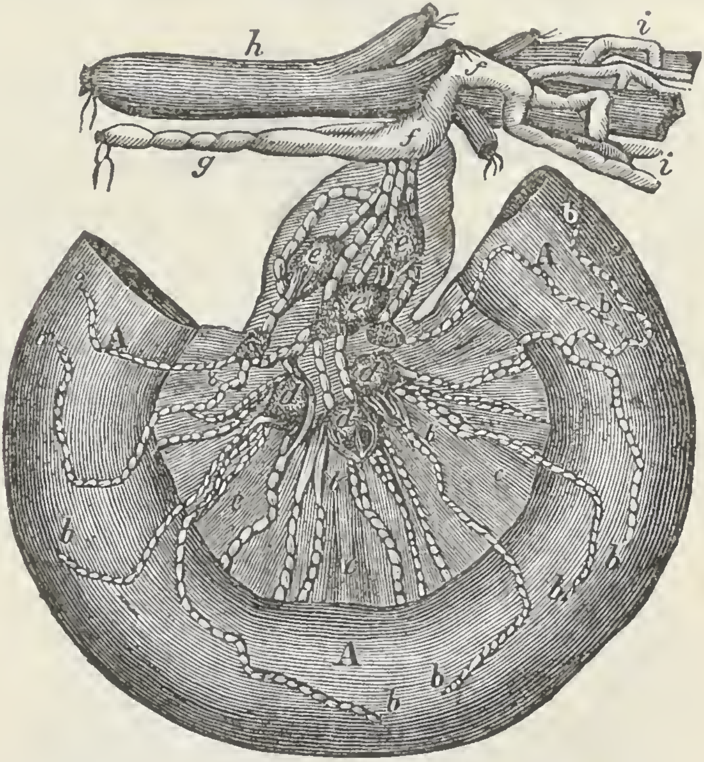
Describe the course of the *thoracic duct*. What is its size? How is the venous blood prevented from passing into this duct?

shaped tube. It is from one to six inches in length, and of the diameter of a goose-quill.

Fig. 87.



A, A, a portion of small intestines ; *b*, *b*, *b*, *b*, superficial lacteals ; *c*, *c*, *c*, a portion of mesentery, or that double fold of the peritoneum which binds the small intestine to the spine ; *d*, *d*, *d*, the first range of mesenteric glands, receiving the small branches of the lacteals from the intestine, and transmitting a few larger branches to the second range ; *e*, *e*, *e*, the second range of mesenteric glands, collecting the branches of lacteals into still larger trunks ; *f*, *f*, the receptacle for the chyle and lymph, being a slight enlargement of the thoracic duct, at its commencement ; *g*, thoracic duct ; *h*, the aorta, or principal artery of the system ; *i*, lymphatics, passing to the thoracic duct.

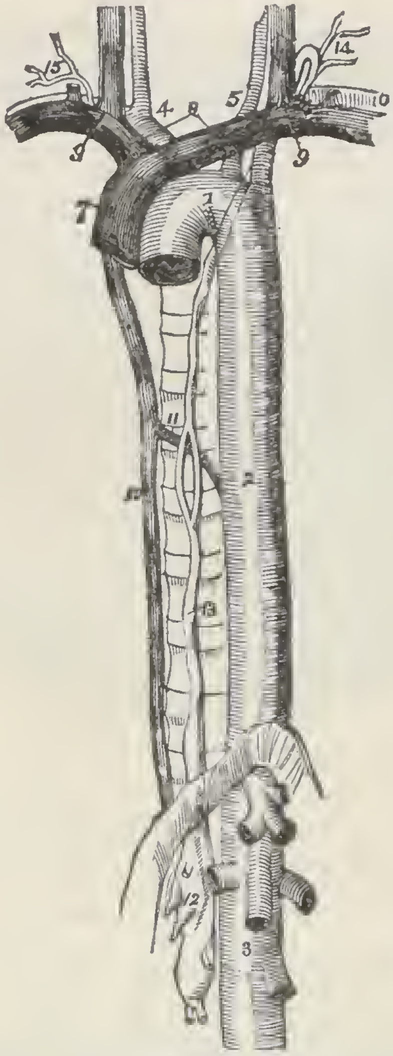
The COLON is divided into three parts ; the *ascending*, the *transverse*, and the *descending*. The ascending colon passes upwards from the right iliac fossa, to the under surface of the liver. It then bends inwards, and crosses the upper part of the abdomen, below the liver and stomach, to the left side, under the name of transverse colon. At the left side it turns and descends to the left iliac fossa, and is called the descending colon. Here it makes a peculiar curve upon itself, which is called sigmoid flexure.

The RECTUM is the termination of the large intestines.

How is the *colon* divided? Describe the ascending colon. The transverse. The descending. Where is the *rectum* situated?

It descends in front of the sacrum, and terminates in the anus, about an inch in front of the extremity of the coccyx.

Fig. 88.



The course and termination of the thoracic duct. 1, Arch of the aorta. 2, Thoracic aorta. 3, Abdominal aorta, showing its principal branches near their origin. 4, The arteria innominata. 5, Left carotid. 7, The superior vena cava, formed by the union of veins from the neck and upper extremities, seen at 9. 10, Vena azygos. 12, The receptaculum chyli; several lymphatic trunks open into it. 13, The thoracic duct; the course of which, behind the aorta, is shown by the dotted line. 14, The duct making its turn at the root of the neck, where it receives several lymphatic trunks. *, The union of the thoracic duct with the transverse vein.

The large intestines have three coats: the external, or serous; the middle, or muscular; and the internal, or mucous. The longitudinal fibres of the muscular coat are

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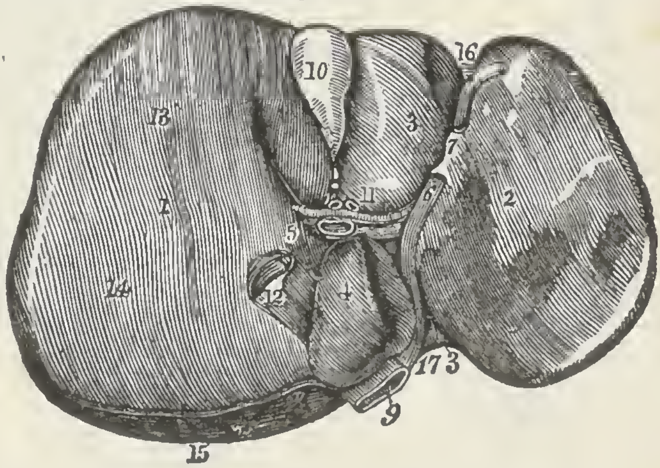
What does fig. 88 represent? How many coats have the large intestines?

collected into three bands. These bands are nearly one half shorter than the intestine, and give it a sacculated appearance, which is characteristic of the cæcum and colon.

The LIVER, a gland appended to the alimentary canal, is the largest organ in the system, and weighs about four pounds. It is situated in the right side, below the diaphragm, and is composed of several lobes. It is retained in its place by several ligaments. Its upper surface is convex; its under, concave. It performs the double office of separating impurities from the venous blood, and of secreting a fluid necessary to chylification, viz. the *bile*. The bile is conveyed, by the ductus choledochus communis, into the *duodenum* — not into the *stomach*.

Fig. 89.



1, The right lobe; 2, the left; 3, 4, and 5, smaller lobes; 6, the longitudinal fissure, in which is seen the round ligament; 7, a portion of liver forming a sort of bridge over this fissure; 8, the continuation of this fissure; 9, the inferior vena cava; 10, the gall bladder lodged in its depression; 11, the transverse fissure, containing from before backwards, the hepatic duct, hepatic artery, and portal vein; 12, the vena cava; 13, a depression corresponding with a curve in the intestine; 14, another depression produced by the right kidney; 15, the posterior edge of the liver; 16, the notch in the anterior border, separating two lobes; 17, the notch on the posterior border, for the vertebral column.

The PANCREAS is a long, flattened gland, analogous to the salivary glands. It is about six inches in length, weighs three or four ounces, and is situated transversely across the posterior wall of the abdomen, behind the stomach. A duct from this organ opens into the duodenum.

What is characteristic of the cæcum and colon? Describe the *liver*. How is it retained in its place? What is its form? What office does the liver perform in the animal economy? Is the bile conveyed into the stomach? Describe the *pancreas*.

Fig. 90.

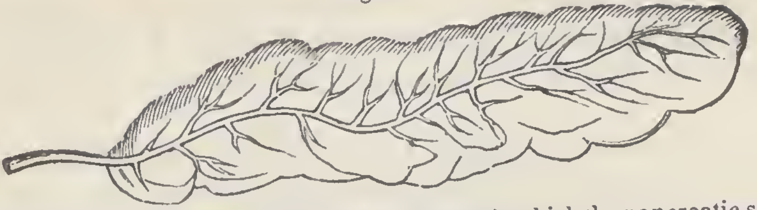


Fig. 90 exhibits the pancreas with its duct, through which the pancreatic secretion passes into the duodenum.

The SPLEEN, so called because the ancients supposed it to be the seat of melancholy, is an oblong, flattened organ, situated in the left side, in contact with the diaphragm, large extremity of the stomach, and the pancreas. It is of a dark, bluish color, and is abundantly supplied with blood, but has no duct which serves as an outlet for any secretion. Its use is not well determined.

Fig. 91.

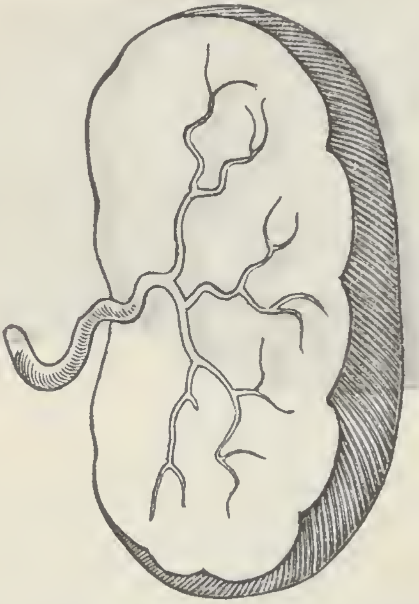


Fig. 91 represents the form of the spleen; the splenic artery is seen entering and ramifying through the organ.

The OMENTUM, or *caul*, consists of four layers of the peritoneum, which descend from the stomach and transverse colon. A quantity of adipose matter is deposited around its vessels, which ramify through its structure. It performs a double function in the animal economy. 1st. It protects the intestines from cold; and 2dly. It facili-

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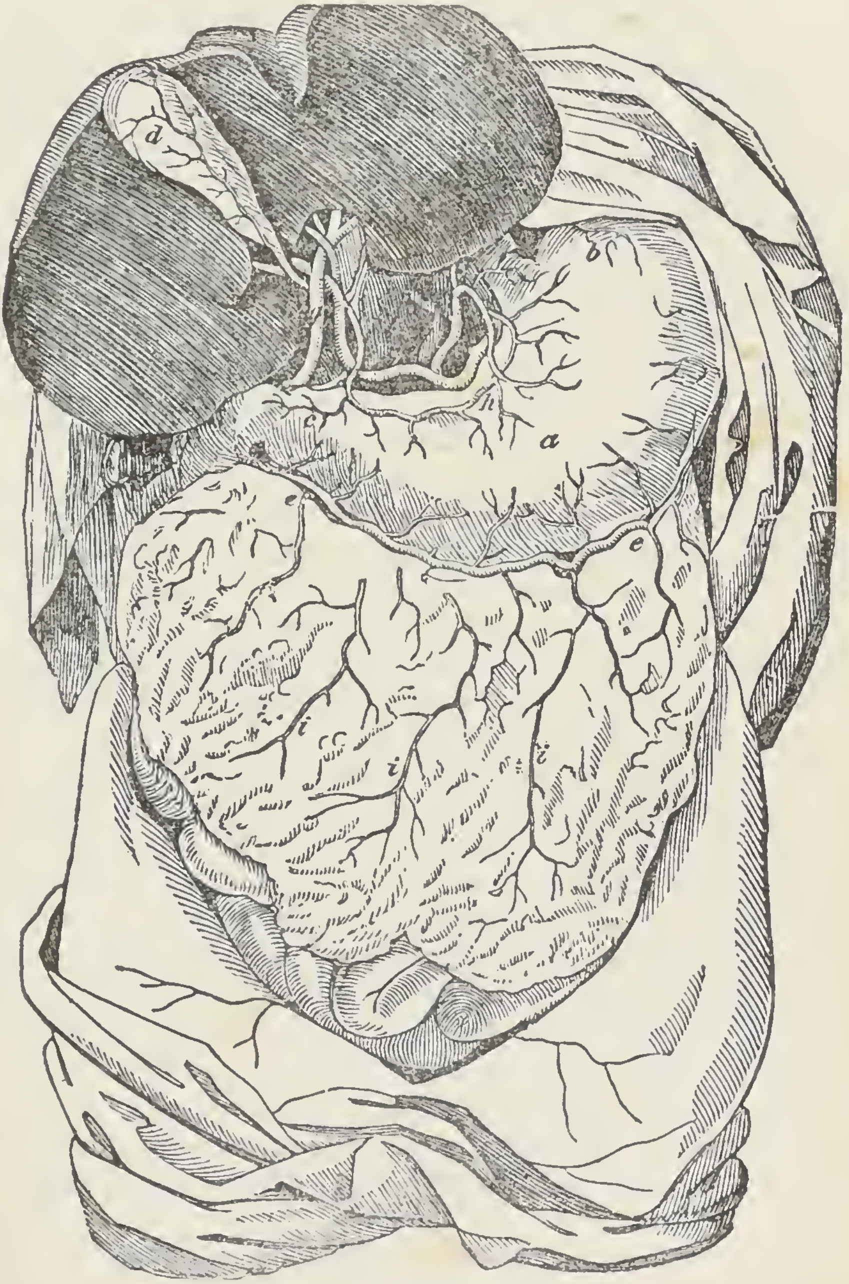
What is the form of the spleen? Why so called? Where is it situated? What is said of the omentum? Its use?

tates the movements of the intestines upon each other, during their vermicular action.

Fig. 92.



In this view of the abdomen, *d*, is the gall-bladder, lying on the under side of the liver, the dark mass to which it is attached; *h*, is the *coronary* artery, which supplies the stomach, *a*, *b*, *c*, with blood. The curve of the stomach is well shown. *e*, *e*, the arteries which supply the caul, marked *i*, *i*, which descend from the front of the stomach, over the intestines, like an apron; *g*, a vessel of the liver.

Every part of the digestive apparatus is supplied with arteries, veins, absorbents or lymphatic vessels, and nervous filaments from the ganglionic system of nerves.

PHYSIOLOGY OF THE DIGESTIVE ORGANS.

The alimentary substances, which serve the purposes of nutrition, require to undergo a peculiar preparation, which is called *digestion.* All solid articles used for food, should be reduced to a state comparatively fine, by the action of the teeth upon them. While the food is in process of mastication, there is incorporated with it, a considerable amount of fluid, named *saliva.* This fluid is furnished by the salivary glands, situated in the vicinity of the mouth. The saliva moistens and softens the food, so that when carried into the pharynx, it is passed, with ease, through the œsophagus into the stomach.

Properly masticated food not only stimulates the coats of the stomach to a contractile effort, but it excites an action in the glands of the stomach. These glands secrete a fluid of great solvent power, named the *gastric juice.* The action of this fluid, aided by the contractile, muscular energy of the stomach, converts the various kinds of food into a homogeneous mass, of a pulpy consistence, which is named *chyme.*

The bile has no agency in the change through which the food passes in the stomach. In a healthy condition of this organ, no bile is found in it. The common belief, that the stomach has a redundancy of bile, is erroneous. If bile be ejected in vomiting, it merely shows, not only that the action of the stomach is inverted, but, also, that of the duodenum. In some cases of hernia, and other diseases of the intestines, the alvine feculent matter is ejected by long-continued and severe vomiting.

The chyme is conveyed through the pylorus, or pyloric orifice of the stomach, into the upper portion of the small intestine, named the duodenum. The chyme not only

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With what is every part of the digestive apparatus supplied? Should solid food be well chewed or masticated? What is mixed with the food when it is properly masticated? What is the use of the saliva? What do the glands of the stomach secrete? By what agency is the food converted into chyme? Has the bile any agency in the change of food in the stomach? Through what orifice of the stomach does chyme pass?

excites an action in the duodenum, but also in the liver and pancreas. *Mucus* is then secreted by the duodenum, *bile* by the liver, and *pancreatic fluid* by the pancreas. The bile and pancreatic fluid are conveyed into the duodenum, and mixed with the chyme. By the action of these different fluids, a portion of the chyme is converted into a fluid of a whitish color, which is named *chyle*.

The chyle and residual matter are moved over the mucous surface of the small intestine, by the action of its muscular coat. This movement is called peristaltic, or vermicular, from its resemblance to the movements of a worm. As the chyle is carried along the tract of the intestine, it comes in contact with the villi, where the lacteal vessels commence. These imbibe or take up the chyle, and transfer it through the mesenteric glands into the thoracic duct, through which it is conveyed into the large vein at the lower part of the neck. In this vein the chyle is mixed with the venous fluid, and the whole is called impure venous blood. The residual matter is conveyed into the cæcum, the first portion of the large intestine.

That portion of the food that is not converted into chyle, is changed into fæces, in the large intestine, from which it is excreted in the alvine discharges.

In the process of digestion, five different changes should be noticed. 1st. The chewing and admixture of the saliva with the food; this process is called *mastication*. 2d. The change, through which the food passes in the stomach, by its muscular contraction, and the secretion from the gastric glands; this is called *chymification*. 3d. The conversion of the pulpy homogeneous chyme, by the agency of the bile and pancreatic secretions, into a fluid of milk-like appearance, called chyle; this is *chylification*. 4th. The absorption of the chyle by the lacteals, and its transfer through them and the thoracic duct, into the subclavian vein. 5th. The changing of the residual, innutritious matter into fæces, and their excretion from the system; this is called *defecation*.

To what is the chyme then changed? By the action of what secretions is it changed into chyle? How is the chyle carried along the intestinal tract? As the chyle passes along the intestinal tract, how is it conveyed into the thoracic duct? What is the chewing of food called? Its change in the stomach? In the duodenum? In the large intestine?

NOTE. — Let the student, from this engraving, review the anatomy and physiology of the digestive organs, that he may see where the different stages of digestion are performed, and by what agents it is effected.

Fig. 93.

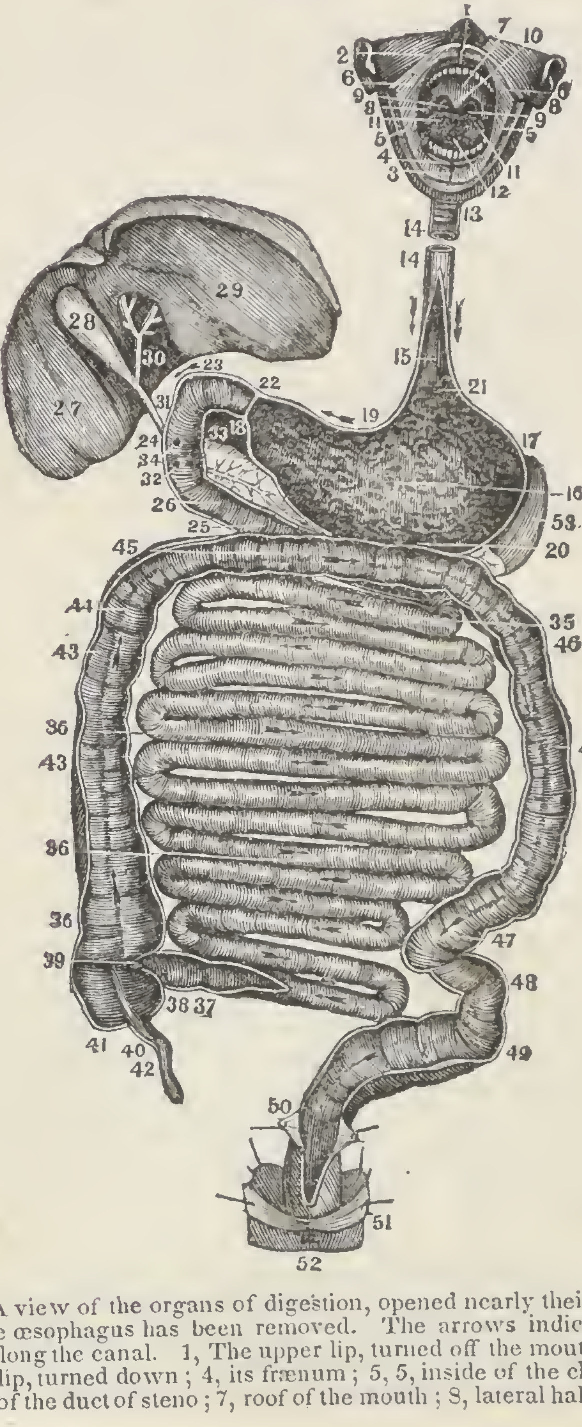

Fig. 93. A view of the organs of digestion, opened nearly their whole length. A portion of the œsophagus has been removed. The arrows indicate the course of substances along the canal. 1, The upper lip, turned off the mouth; 2, its frænum; 3, the under lip, turned down; 4, its frænum; 5, 5, inside of the cheeks; 6, points to the opening of the duct of steno; 7, roof of the mouth; 8, lateral half arches; 9, points

to the tonsils; 10, velum palati; 11, surface of the tongue; 12, papillæ near its point; 13, a portion of the trachea; 14, the œsophagus; 15, its internal surface; 16, inside of the stomach; 17, its greater extremity; 18, its lesser extremity; 19, its lesser curvature; 20, its greater curvature; 21, the cardiac orifice; 22, the pyloric orifice; 23, upper portion of the duodenum; 24, 25, remainder of duodenum; 26, its valvulæ conniventes; 27 and 29, the liver; 28, the gall bladder; 30, hepatic duct; 31, ductus communis choledochus; 32, its opening into the duodenum; 33, pancreas; 34, its opening into the duodenum; 35, upper part of the jejunum; 36, ilium; 37, some of the valvulæ conniventes; 38, lower extremity of the ilium; 39, ileo-colic valve; 40, 41, cæcum, or caput coli; 42, vermiform appendage; 43, 44, ascending colon; 45, transverse colon; 46, 47, descending colon; 48, sigmoid flexure of the colon; 49, upper portion of the rectum; 50, its extremity; 51, portion of the levator ani muscle; 52, the anus; 53, the spleen.

PRACTICAL SUGGESTIONS.

It *is a law of the system, that each organ is excited to healthy and efficient action, when influenced by its appropriate stimulus.* Accordingly nutrient food that is adapted to the wants of the system, imparts a healthy stimulation to the salivary glands, during the process of mastication. The food that is well masticated, and has blended with it a proper amount of saliva, will induce a healthy action in the stomach, as this is its appropriate stimulus. Well prepared chyme is the natural stimulus of the duodenum, liver, and pancreas; perfectly elaborated chyle is the appropriate excitant of the lacteal vessels.

Hence, if the processes of *mastication* and *insalivation* are defective, all the subsequent changes in the digestion of food will be imperfect. If *chymification* or *chylification* be faulty, the changes of the food in the ulterior digestive process will be incomplete.

The perfection of the digestive process, as well as the health of the general system, requires the observance of certain conditions. These will be considered under four heads. 1st. The quantity of food that should be taken. 2nd. Its character. 3d. The manner in which it should be taken. 4th. The condition of the system at the time when taken.

1. The quantity of food necessary for the system, is regulated by two circumstances;—*the rapidity of growth, and the amount of waste matter removed from the system in a given time.* The lad that exercises, and grows fast, not

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Give a law of the animal economy. What is the natural stimulus of the salivary glands? Of the stomach? Of the duodenum? Of the lacteal vessels? What effect has defective mastication or insalivation on the digestive process? How is the quantity of food taken regulated? Why does the lad require more food than the man of mature years?

only needs food to promote the growth of the bones and muscles, but material to repair the waste of the system. Hence, we notice in the healthy, growing child, the frequent call for food, the keen appetite, and vigorous digestion. When the system is matured, there is less demand for food, as only a quantity sufficient to supply the loss attendant on the action of the skin, liver and other organs, is required.

In every department of nature, waste, or loss of substance, follows action. The great toe of the bronze statue of St. Peter, at Rome, has been reduced in size, one half, by the kissing of the Romanist devotees; thus, kissing is attended with waste. The lad, or man, who is active, requires more nourishment than one of indolent habits; as the waste of one's system exceeds that of the other. The individual who has been accustomed to active employment, as agriculture, on leaving it, to pursue an employment of an opposite character,—as the learning of a sedentary trade, attending school, or engaging as a clerk,—requires less nutriment, as the waste of the system is diminished in the same proportion as the exercise is lessened. If the same amount of food be taken after the diminution of the exercise, as before, a diseased condition of the system will be produced. *Students should guard against this evil the first few weeks of attending school; so should girls, who leave active household duties, for sedentary labor in the shop of the dress-maker.*

The necessity of diminishing the amount of food when the exercise is lessened, should be impressed on the mind of the student. The physical health not only requires this, but the mental and moral attainments demand it. If the digestive organs of the pupil have been previously impaired, and continue in a debilitated state, the observance of this suggestion is of very great importance.

2. The quality of the food should be adapted to the distensible character of the stomach and intestines. The former will be full, if it contain only a gill. It may be so distended as to contain a quart. The same is true of the intestines. Consequently, if the food contain the quan-

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In every department of nature what is attendant on action? Does the man of sedentary habits require as much food as an active agriculturist? Why not? What caution is given to students? What is said of the distensible character of the stomach and intestines?

tity of nutriment, in small bulk, which the system requires, the stomach and intestines will need the stimulation of distension and friction, which is consequent upon the introduction and transit of the innutritious material, into and through the alimentary tract.

If the food be deficient in innutritious matter, the tendency is, to produce an inactive and diseased condition of the digestive organs. Consequently, the *nutrient food should have, blended with it, innutritious material. Unbolted wheat bread* is more healthy than *flour cakes; ripe fruits* and *vegetables*, than *rich jellies.*

The observance of this condition is of more importance to students, sedentary mechanics, and those individuals whose digestive apparatus has been enfeebled, than those of active habits and firm health. This point has been and may be illustrated by experiments upon the lower orders of animals. Feed a dog with pure sugar, or olive oil, (articles that contain no innutritious matter) for several weeks, and the evil effects of concentrated nutriment will be manifested. At first, the dog will take his food with avidity, and seem to thrive upon it; soon his desire for food will diminish, his body emaciate, his eye become ulcerated, and in a few weeks he will die. But mix with the sugar or oil, bran or saw dust, and the health and vigor of the animal will be maintained for months. Similar phenomena will be manifested, if grain only be given to a horse, without hay, straw, or material of like character.

3. Food should be taken at stated periods. The interval between meals should be modified by the character of the food, the age, health, exercise, and habits of the individual. The digestive process is more energetic and rapid in the young, active and vigorous, than in the aged, indolent, and feeble: consequently, food should be taken more frequently by the former than the latter class. In some young and vigorous persons, food may be digested in one hour; in other persons, it may require four hours or more. In most instances, from two to four hours will be required to digest ordinary meals. In *all* instances, the stomach will require from one to three hours, to re-

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What kind of aliment is best adapted to the system? Why should there be a combination of nutritious and innutritious matter in our diet? Give an experiment of feeding animals on nutrient material only? How should food be taken? How often? How long should the stomach rest after the food has been digested?

cruit its exhausted powers after the labor of digesting a meal, before it will again enter upon the vigorous performance of its functions. If food be taken before the stomach has regained its tone and energy by repose, the secretion of the gastric juice, and the contraction of the muscular fibres, will be imperfect. Again, if food be taken before the digestion of the preceding meal has been completed, the effects will be still worse, because the food partially digested becomes mixed with that last taken. The interval between each meal should be long enough for the whole quantity to be digested, and the time of repose should be sufficient to recruit the exhausted organs. The more feeble the person, and the more debilitated the stomach, the more important to observe the above direction. In the feeding and nursing of infants, as well as in supplying food to older children, it should always be regarded. The person who has been confined by an exhausting sickness, should most scrupulously regard this rule, if he would recruit his strength and flesh with rapidity. As the rapidity of the digestive process is less in students and persons who are engaged in sedentary employments, than in stirring agriculturalists, the former classes are more liable to violate this condition than the latter, while its observance is of greater importance to the sedentary artisan than to the lively lad and active farmer. Hence, the attention of the sedentary and feeble is particularly invited to the suggestions of this paragraph.

The following table exhibits the general results of experiments on Alexis St. Martin, by Dr. Beaumont, when he endeavored to ascertain the time required for the digestion of different articles of food. The stomach of St. Martin was torn open by the bursting of a gun. When he recovered from the effects of the accident, under the surgical care of Dr. Beaumont, the stomach became adherent to the side, with an external aperture. Through this opening, the appearance of the coats of the stomach, and food at different stages of digestion, were examined.

What will be the effect, if food be taken before the stomach has regained its tone and vigor? Should food be taken into the stomach before a preceding meal has been digested? How long should be the interval between each meal? What is said of Alexis St. Martin? Mention the mean time required for the digestion of different articles of diet in the following table.

A TABLE

Showing the mean time required for the digestion of the different articles of diet.

Articles of Diet.	Mode of Preparation.	Time required for Digestion.	
		H.	M.
Rice,	Boiled.	1	
Pigs' feet, soused,	Boiled.	1	
Tripe, soused,	Boiled.	1	
Eggs, whipped,	Raw.	1	30
Trout and Salmon, fresh,	Boiled.	1	30
Soup, barley,	Boiled.	1	30
Apples, sweet and mellow,	Raw.	1	30
Venison steak,	Broiled.	1	35
Brains,	Boiled.	1	45
Sago,	Boiled.	1	45
Tapioca,	Boiled.	2	
Barley,	Boiled.	2	
Milk,	Boiled.	2	
Beef's liver, fresh,	Broiled.	2	
Eggs, fresh,	Raw.	2	
Codfish, cured, dry,	Boiled.	2	
Eggs, fresh,	Roasted.	2	15
Apples, sour and mellow,	Raw.	2	
Cabbage, with vinegar,	Raw.	2	
Turkey, wild,	Roasted.	2	18
" domestic,	Boiled.	2	25
Milk,	Raw.	2	15
Gelatine,	Boiled.	2	30
Turkey and Goose, domestic,	Roasted.	2	30
Pig, sucking,	Roasted.	2	30
Lamb, fresh,	Broiled.	2	30
Hash, meat and vegetables,	Warmed.	2	30
Beans, pod,	Boiled.	2	30
Cakes, sponge,	Baked.	2	30
Parsnip,	Boiled.	2	30
Potatoes, Irish,	Roasted.	2	30
" "	Baked.	2	30
Cabbage, head,	Raw.	2	30
Spinal marrow,	Boiled.	2	40
Chicken, full grown,	Fricassee.	2	45
Custard,	Baked.	2	45
Beef, with salt only,	Boiled.	2	45
Apples, sour and hard,	Raw.	2	50
Oysters, fresh,	Raw.	2	55
Eggs, fresh,	Soft Boiled.	3	
Bass, striped, fresh,	Broiled.	3	
Beef, fresh, rare, and lean,	Roasted.	3	
Pork, recently salted,	Raw.	3	
" " "	Stewed.	3	

Articles of Diet.	Mode of Preparation.	Time required for Digestion.	
		H.	M.
Beef and mutton, steak,	Broiled.	3	
Mutton, fresh,	Boiled.	3	
Soups, bean and chicken,	Boiled.	3	
Aponeurosis,	Boiled.	3	
Cake, corn,	Baked.	3	
Dumpling, apple,	Boiled.	3	
Oysters, fresh,	Roasted.	3	15
Pork, steak,	Broiled.	3	15
Pork, recently salted,	Broiled.	3	15
Mutton, fresh,	Roasted.	3	15
Bread, corn,	Baked.	3	15
Carot, orange,	Boiled.	3	15
Sausage, fresh,	Broiled.	3	20
Flounder, fresh,	Fried.	3	30
Cat-fish, fresh,	Fried.	3	30
Oysters, fresh,	Stewed.	3	30
Beef, fresh, dry,	Roasted.	3	30
Beef, with mustard, &c.	Boiled.	3	30
Butter,	Melted.	3	30
Cheese, old and strong,	Raw.	3	30
Soups, mutton and oyster,	Boiled.	3	30
Bread, wheaten, fresh,	Baked.	3	30
Turnips, flat,	Boiled.	3	30
Potatoes, Irish,	Boiled.	3	30
Eggs, fresh,	Hard boiled.	3	
" "	Fried.	3	
Green Corn, Beets and Beans,	Boiled.	3	45
Salmon, salted,	Boiled.	4	
Beef, fresh and lean,	Fried.	4	
Veal, fresh,	Broiled.	4	
Fowls, domestic,	Boiled.	4	
" "	Roasted.	4	
Ducks,	Roasted.	4	
Soup, (beef, vegetables and bread,)	Boiled.	4	
Heart, animal,	Fried.	4	
Beef, old, hard, and salted,	Boiled.	4	15
Pork, recently salted,	Fried.	4	15
Soup, marrow bones,	Boiled.	4	15
Cartilage,	Boiled.	4	15
Pork, recently salted,	Boiled.	4	15
Veal, fresh,	Fried.	4	30
Ducks, wild,	Roasted.	4	30
Suet, mutton,	Boiled.	4	30
Cabbage, with vinegar,	Boiled.	4	30
Suet, beef, fresh,	Boiled.	5	3
Pork, fat and lean,	Roasted.	5	15
Tendon,	Boiled.	5	30

Food should be taken, not only at stated periods, but in a proper manner. All solid aliment should be reduced to a state of comparative fineness before it is swallowed; the gastric fluid of the stomach will then blend with it more readily, and act more vigorously in reducing it to chyme.

The practice of swallowing solid food, slightly masticated, or bolting it down, tends to derange the digestive process, and impair the nutrition of the system.

Mastication should be moderate, not *rapid*, for the salivary glands are excited to action in chewing, and some time must elapse before they can secrete saliva in sufficient quantities to moisten the food. If the aliment is not supplied with saliva, it retards digestion. Hence, *rapid* or fast eating, has a tendency to induce disease.

As the salivary glands supply fluid to moisten the dry food, the use of *tea*, *coffee*, water, or any other fluid, is not demanded by nature's laws, while taking a meal. There are two objections to washing down the food with considerable quantities of common drinks. One is, the aliment is moistened, not with the saliva, but with the drink. This tends to induce disease in the salivary organs, by leaving them in a state of comparative inactivity, and in the stomach, by the deficiency of the salivary stimulus. The other is, large quantities of fluids, used as drinks, give undue distension to the stomach, and lessen the energy of the gastric juice by its dilution. The horse is never known to leave his provender, or the ox his blade of grass, to wash it down; but many persons, from habit, rather than thirst, drink largely during meals. While the washing down of food is productive of evil, a moderate amount of drink, *after* eating, aids in the digestion of food.

Liquids and food should not be taken very hot; when so taken, the vessels of the mucous membrane of the gums, mouth and stomach, are unduly stimulated for a short time, and this is followed by reaction, attended with a loss of tone, and debility of the mucous membrane. This practice

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Should the manner of taking food as well as regularity be noticed? What is said of the practice of 'bolting down' the food? What is said of rapid eating? What objections to the use of tea and coffee? When would a moderate amount of drink aid digestion? What is the effect when liquids are drank hot?

is a fruitful cause of spongy gums, decayed teeth, sore mouth and indigestion.

Again, if a considerable quantity of very cold food or liquids, be taken immediately into the stomach, the health will be endangered, and the tone of the system will be impaired, from the sudden abstraction of heat from the coats of the stomach, and surrounding organs, to impart warmth to the cold food or drink. Consequently, food and drink should not be taken very hot or very cold, but moderately heated; this is best adapted to the natural condition of the digestive apparatus.

Food should not be taken immediately after severe manual or mental exertions. For all organs in action, require and receive more blood and nervous fluid, than when at rest. This is the case with the brain and limbs when exercised; and the same is true of the stomach and intestines, during the digestion of food. The increased amount of fluid, both sanguineous and nervous, supplied to any organ during *extra* functional action, is abstracted from other parts of the system. This enfeebles and prostrates the parts that supply the blood and nervous fluid to the active organ. Again, when any organ has been in vigorous action for a few hours, some time will elapse before the increased action of the arteries and nerves abates, and a due supply of fluids is transmitted to other organs, or an equilibrium of action in the system is re-established.

If the muscles are called into vigorous action, by labor, walking or running, there will be a determination of blood and nervous fluid to them. The digestive organs will be in a state of comparative inactivity, and consequently unfit to digest food. For this reason, severe exercise should not be taken immediately after eating a full meal. Nor should the respiratory or vocal organs be called into active exercise in declaiming or singing; nor the brain be employed in continued thought, for an hour or two, *before* or *after* taking a full meal. But moderate exercise of

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What is the effect, when liquids are taken iced or cold? What temperature of liquids is adapted to the system? Should food be taken immediately after manual or mental exertion? Give the reasons why it should not. Why should not the respiratory or vocal organs be called into active exercise immediately before or after eating? What facilitates digestion?

the muscular system, conjoined with agreeable conversation and a hearty laugh, facilitates digestion.

To illustrate this principle,—feed two dogs upon similar articles of food; let one lie down quiet, and the other be sent in pursuit of game. At the expiration of one hour, have them killed. The stomach of the one that had remained quiet, will be nearly or quite empty, while the food in the other will be found nearly unaltered. In the one the energies of the system have been concentrated upon the stomach; in the other they have been exhausted on the organs of motion. So it is with man; if his mind or muscles act intensely, soon after eating, the stomach will not be sufficiently stimulated to change the food in a suitable period. If food be retained in the stomach an unusual length of time, irritation will be produced.

The mind exerts an influence upon the digestive process. This is clearly exhibited, when an individual receives the intelligence of the loss of a friend or of property. He may at the time be sitting before a plentiful board, with a keen appetite; but the unexpected news destroys it, because the excited brain withholds its stimulus. Indigestion arising from a prostration of the nervous system should be treated with great care. The food should be simple, nutritious, moderate in quantity, and taken at regular periods. Large quantities of stimulating food, frequently taken, serve to increase the nervous prostration. Those afflicted should exercise in the open air, and engage in social conversation, that the brain may be excited to a natural or healthy action, in order that it may impart to the digestive organs the necessary stimuli.

It is no unusual occurrence, that those persons who have eaten heartily immediately before retiring for sleep, have unpleasant dreams, or they are aroused from their unquiet slumber by colic pains. In such instances the brain becomes dormant, and does not impart to the digestive organs the requisite amount of nervous fluid. The nervous stimulus being deficient, the unchanged food remains in the stomach, causing irritation of this organ.

What example is given, to illustrate the effects of calling two leading organs into action at the same time? Has the mind any effect on digestion? Relate an instance from common observation. What is said of indigestion arising from a prostration of the nervous system? What effect has the eating of food immediately before retiring?

The practical rule should be, *to abstain from eating at least three hours before retiring for sleep.*

The condition of the skin exercises an important influence on the digestive apparatus. Let free perspiration be checked, either from uncleanliness, or from chills, and it will diminish the functional action of the stomach and its associated organs. This is one of the fruitful causes of the 'liver and stomach complaints,' among the half-clothed and filthy population of the crowded cities and villages of our country.

Restricting the movements of the ribs and diaphragm impairs digestion, not only by preventing the oxydation of the blood in the lungs, but by impeding the action of the abdominal viscera induced by the elevation and depression of the diaphragm. At each full inspiration, the ribs are elevated, and the central portion of the diaphragm is depressed, from one to two inches. This depression is accompanied by a relaxation of the anterior abdominal muscles. At each act of expiration, the relaxed abdominal muscles contract, the ribs are depressed, the diaphragm relaxes, and its central parts ascend. These movements of the midriff cause the elevation and depression of the stomach, liver, and other abdominal organs. It is noted of individuals who restrain the free movements of the abdominal muscles by tight dresses, that the tone and vigor of the digestive organs are diminished. The restricted waist will not admit of a full and deep inspiration; and so essential is this to health, that abuse in this respect soon enfeebles and destroys the functions of the system.

The effect of impure blood, in diminishing the desire for food, and enfeebling the digestive organs, is well illustrated by the following incident. During the sitting of the committee appointed by the British Parliament, to inquire into the effects that manufacturing employment had upon the physical system, among several persons examined, one stated, that some years before he had ventilated

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What practical rule is given? Is there sympathy between the skin and the digestive organs? What is one fruitful cause of liver complaints among the poorly-clothed inhabitants of crowded cities and villages? Why does restricting the movements of the ribs and diaphragm impair digestion? Does inspiration affect the abdominal organs? How? What effect has impure blood upon the digestive organs? Give the statement of an English manufacturer.

his mill, on a well-devised plan. The apparatus was removed at a subsequent period. On being asked the reason for removing it, he replied, he noticed after the mill was ventilated, that his men consumed a greater quantity of food; and rather than incur an extra expense for beef, he caused the ventilating apparatus to be taken out. From this testimony we learn the reason why those persons who sleep in small, badly-ventilated rooms, have little or no appetite in the morning, and why the mouth and throat are so dry and filthy.

Fig. 94. Fig. 95.

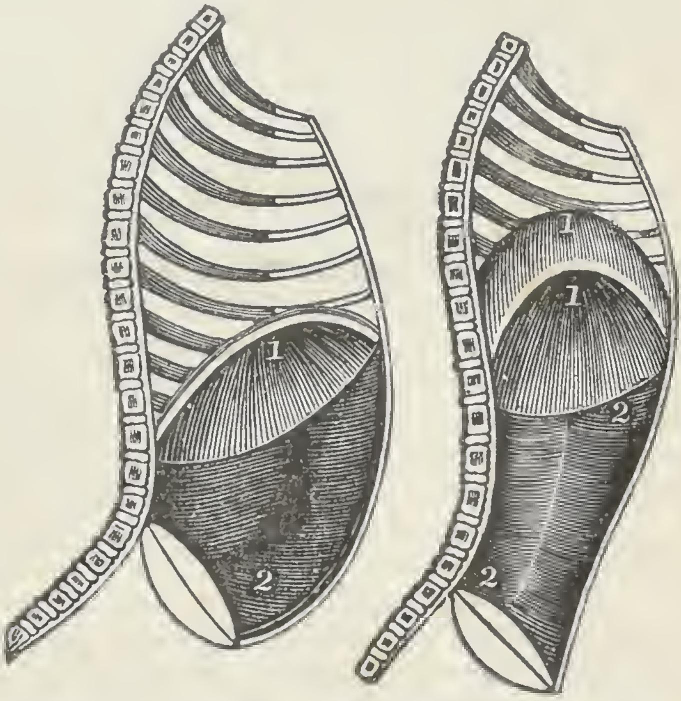

Fig. 94, represents the antero posterior section of the chest when the lungs are inflated. Fig. 1, The diaphragm. 2, The muscular walls of the abdomen.

Fig. 95, represents the antero posterior section of the thorax, or chest, when the lungs are contracted. 1, 1, The diaphragm. 2, 2, The muscular walls of the abdomen.

These engravings show the diaphragm to be more convex, and the walls of the abdomen more flattened, when the lungs are contracted, than when they are inflated.

The position of a person, when standing or sitting, exerts an influence upon the digestive organs. If a person lean, or stoop forward, the distance between the pelvic bones and the diaphragm is diminished. This prevents the depression of the diaphragm, while the stomach, liver,

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What do Figs. 94 and 95 show? How do the attitudes affect digestion?

pancreas, and other abdominal organs, suffer compression, which induces many severe diseases of these viscera. As healthy and well-developed muscles keep the spinal column in an erect position, which conduces to the health of the organs of digestion, the child should be taught to avoid all positions *but the erect*, while studying or walking. This position, combined with unrestricted waists, will do much to remove the now prevalent disease, dyspepsia.

In warm weather, the vessels of the skin are more active than in cold. This is attended by a comparatively enfeebled state of the stomach, and an increased irritability of the intestinal tract. This condition of the system points to the necessity of diminishing the quantity of aliment taken, and also of its being less stimulating in character, in warm, than in cold weather. By observing this suggestion, clothing and bathing the system properly, diseases of the intestines, or ‘ season complaints,’ would, to a considerable extent, be prevented.

Whatever kind of aliment be taken, it is separated into nutriment and excrement, the former of which is conveyed, through the medium of the circulation, to all organs of the system, and the latter, if not expelled, accumulates, causing headache and dizziness, with a general uneasiness, and, if allowed to continue, it lays the foundation of a long period of suffering and disease. For the preservation of health it is necessary that there should be a daily evacuation of the alvine matter. We would add, for the benefit of those affected with hemorrhoids, that the best time for evacuating the system, would be immediately before retiring for sleep. To recapitulate : digestion is most perfect, when the action of the cutaneous vessels is energetic ; the brain and vocal organs moderately stimulated by animated conversation ; the blood well purified ; the muscular system duly exercised ; the food taken at regular periods, and properly masticated.

Before leaving this branch of the subject, however, it may be useful to lay before the reader, as a kind of summary, the principal inferences deduced by Dr. Beaumont, from his numerous experiments and observations. And,

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What is the usual condition of the digestive organs in very warm weather ? What caution relative to the food in warm weather ? What other directions are given for the prevention of ‘season complaints,’ as they are termed ?

in so doing, we shall attempt to arrange the results in their natural order; for in the original work they are given without reference either to logical sequence or to time:

INFERENCES FROM DR. BEAUMONT'S EXPERIMENTS AND OBSERVATIONS.

'1. That *hunger* is the effect of *distention* of the vessels that secrete the gastric juice.

2. That the processes of *mastication*, *insalivation*, and *deglutition*, in an abstract point of view, do not in any way affect the digestion of food; or, in other words, when food is introduced directly into the stomach, in a finely-divided state, without these previous steps, it is as readily and as perfectly digested, as when they have been taken.

3. That *saliva* does not possess the properties of an alimentary solvent.

4. That the *agent* of chymification is the *gastric juice.*

5. That the pure gastric juice is a fluid, *clear* and *transparent*, without *odor*, a little salt, and perceptibly *acid.*

6. That it contains free *muriatic acid*, and some other active chemical principles.

7. That it is never found *free* in the gastric cavity; but is always excited to discharge itself by the introduction of *food* or other irritants.

8. That it is secreted in vessels distinct from the mucous follicles.

9. That it is seldom obtained pure, but is generally mixed with mucus, and sometimes with saliva. When pure, it is capable of being kept for months, and perhaps for years.

10. That it *coagulates* albumen, and afterwards *dissolves* the coagula.

11. That it *checks* the progress of putrefaction.

12. That it acts as a *solvent* of food, and alters its properties.

13. That, like other chemical agents, it *commences* its action on food as soon as it comes in contact with it.

14. That it is capable of combining with a certain fixed *quantity* of food, and, when more aliment is presented for

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What are the inferences from Dr. Beaumont's experiments and observations?

its action than it can dissolve, disturbance of the stomach, or 'indigestion,' will ensue.

15. That its action is facilitated by the warmth and motions of the stomach.

16. That it becomes intimately *mixed* and *blended* with the ingesta in the stomach, by the motions of that organ.

17. That it is *invariably* the *same substance*, modified only by *admixture* with other fluids.

18. That the motions of the stomach produce a constant *churning* of its contents, and *admixture* of food and gastric juice.

19. That these motions are in two directions, *transverse* and *longitudinal.*

20. That *no other* fluid produces the same effect on food that gastric juice does; and that it is the only solvent of aliment.

21. That the action of the stomach and its fluids, is the same on *all kinds* of diet.

22. That *solid* food, of a certain texture, is easier of digestion than *fluid.*

23. That *animal* and *farinaceous* elements are more easy of digestion than vegetable.

24. That the susceptibility of digestion does not, however, depend altogether upon *natural* or *chemical* distinction.

25. That digestion is facilitated by *minuteness of division* and *tenderness of fibre*, and retarded by opposite qualities.

26. That the *ultimate principles* of aliment are always the same, from whatever food they may be obtained.

27. That *chyme is homogeneous*, but variable in its *color* and *consistence.*

28. That towards the *latter* stages of chymification, it becomes more *acid* and *stimulating*, and passes more rapidly from the stomach.

29. That the *inner coat* of the stomach is of a pale *pink* color, varying in its hues according to its full or empty state.

30. That in health it is sheathed with mucus.

31. That the appearance of the stomach, *in disease*, is essentially different from that of its *healthy* state.

32. That stimulating *condiments* are injurious to the healthy stomach.

33. That ardent spirits *always* produce diseases of the stomach, if persevered in.

34. That *water, ardent spirits,* and most other *fluids,* are not affected by the gastric juice, but pass from the stomach soon after they have been received.

35. That the *quantity* of food generally taken is more than the wants of the system require; and that such excesses, if persevered in, generally produce, not only functional aberrations, but also diseases of the coats of the stomach.

36. That *bulk,* as well as *nutriment,* is necessary to the articles of diet.

37. That *bile* is not ordinarily found *in the stomach.*

38. That *oily* food is difficult of digestion, though it contains a large proportion of the nutrient principles.

39. That the *digestibility* of aliment does not depend upon the *quantity* of nutrient principle that it contains.

40. That the natural temperature of the stomach is about 100 degrees Fahrenheit.

41. That the temperature is *not elevated* by the ingestion of food.

42. That *exercise elevates* the temperature; and that *sleep,* or *rest,* in a recumbent position, *depresses* it.

43. That *gentle exercise* facilitates the digestion of food.

44. That the time required for that purpose is various, depending on the quantity and quality of the food, state of the stomach, &c.; but that the time ordinarily required for the disposal of a moderate meal of the fibrous parts of meat, with bread, &c., is from three to three and a half hours.'

The first and second inferences are probably erroneous, and the seventeenth is, perhaps, too strongly expressed. A complete change of diet, for example, causes *some* variation in the gastric juice, although the latter inference, taken in a literal sense, affirms the contrary.

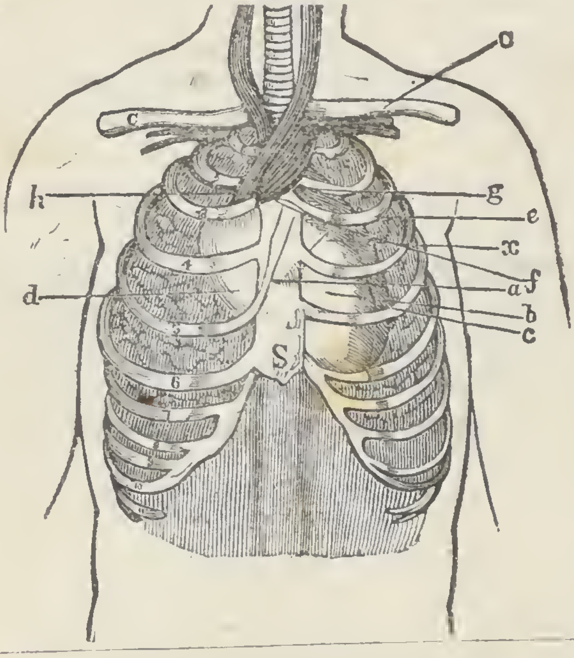
CHAPTER VII.

ORGANS OF RESPIRATION.

THE organs of respiration are the *lungs*, the *larynx*, and the *trachea*. The ribs, the diaphragm, and several muscles are also subservient to the respiratory process.

The THORAX, sometimes called the *chest*, is bounded posteriorly by the spinal column, posterior extremity of the ribs, and the intercostal muscles; laterally by the ribs and intercostal muscles; anteriorly, by the sternum, anterior extremity of the ribs, and the cartilages which connect the ribs to the sternum; inferiorly, by the diaphragm, which separates this cavity from the abdomen. The natural form of the chest is a truncated cone. The correct form of the chest, and the position of the organs contained in it, are represented by the three following engravings.

Fig. 96.



Name the organs of respiration. How is the *thorax* bounded? Its form? What does fig. 96 exhibit?

Fig. 96, represents the position of the heart and lungs, as they lie in the chest; C, C, the collar bones; from 1 to 10, the ribs, the two lower of which are not seen. The lines crossing the ribs at the right of the figures, designate the manner in which the ribs are connected with the breast bone; *a*, the right ventricle; *b*, the left ventricle, *c*, division between the two; *x*, *d*, the right auricle; *e*, the left auricle; *g*, pulmonary artery; *h*, the descending vena cava, the vessel which returns the collected venous blood of the head and upper extremities; S, the cartilaginous extremity of the breast bone. In this engraving, the spaces between the ribs are not filled by the intercostal muscles. The lungs and heart are seen between the interstices of the ribs.

Fig. 97.

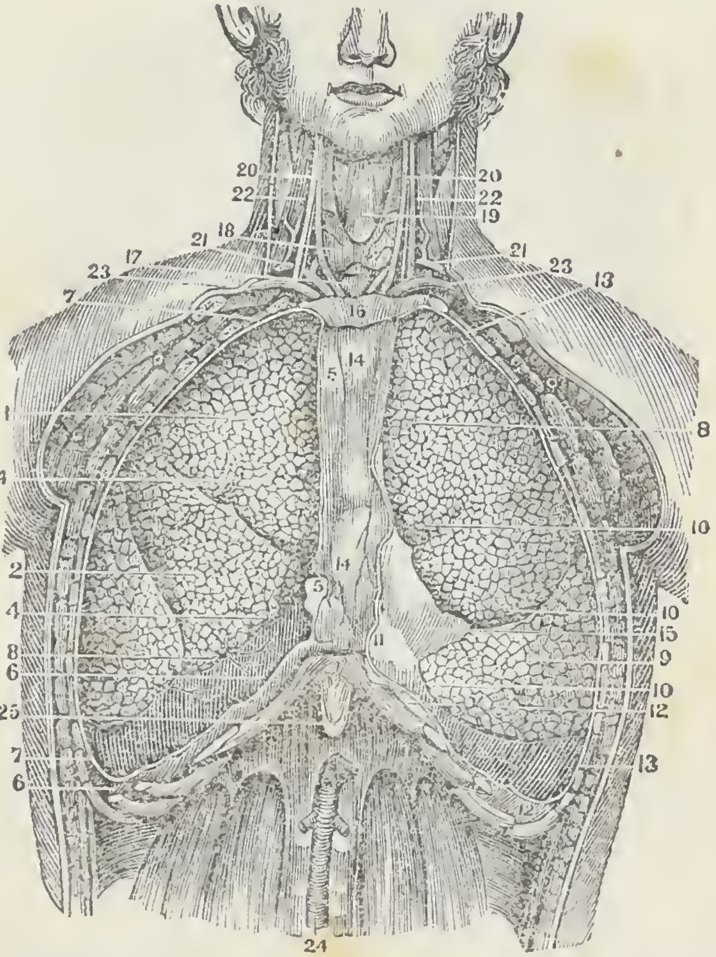


Fig. 97. An anterior view of the thoracic viscera, showing their relative position, by the removal of the anterior walls of the chest. 1, the superior lobe of the right lung; 2, its middle lobe; 3, its inferior lobe; 4, 4, lobular fissures; 5, 5, the internal layer of the costal pleura, forming the right side of the anterior mediastinum; 6, 6, the portion of the pleura that lines the right side of the diaphragm; 7, 7, the pleura costalis of the right side; 8, superior lobe of the left lung; 9, its inferior lobe; 10, 10, interlobular fissures; 11, the portion of the pleura costalis which forms the left side of the anterior mediastinum; 12, the portion of the pleura which covers the right side of the diaphragm; 13, the left pleura costalis; 14, 14, the middle space between the pleuræ, known as the anterior mediastinum; 15, the pericardium; 16, the fibrous partition over which the pleuræ are reflected; 17, the trachea; 18, the thyroid gland; 19, the anterior portion of the thyroid cartilage; 20, the primitive carotid artery; 21, the subclavian vein; 22, the internal jugular vein; 23, the brachio-cephalic vein; 24, the abdominal aorta; 25, the ensiform cartilage.

Fig. 98.

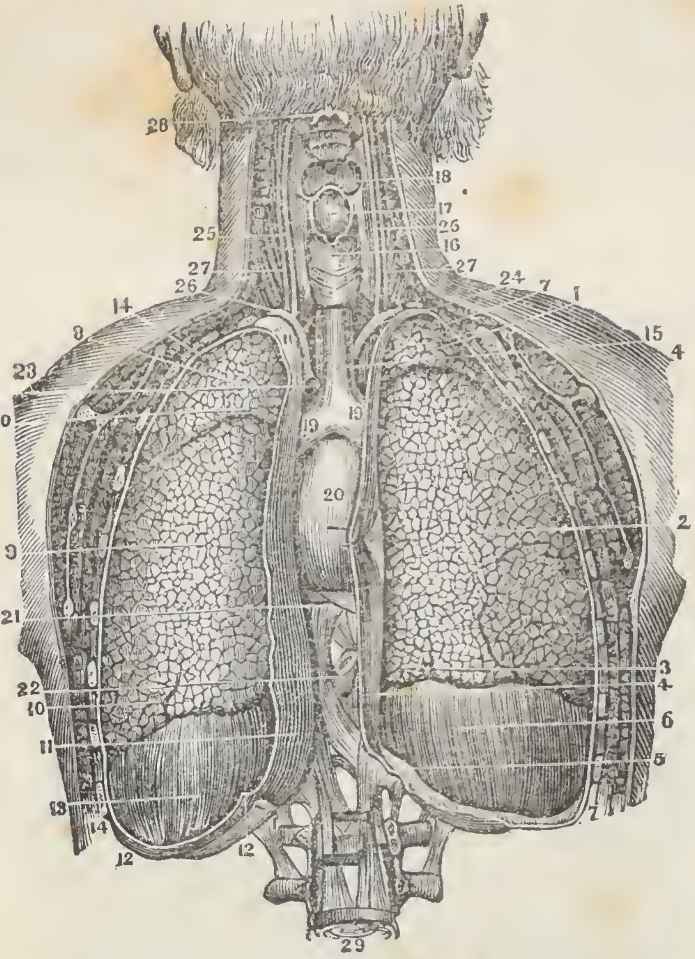


Fig. 98. A posterior view of the thoracic viscera, showing their relative position, by the removal of the posterior portion of the walls of the chest. 1, 2, the upper and lower lobes of the right lung; 3, interlobular fissures; 4, the internal portion of the pleura costalis, forming one of the sides of the posterior mediastinum; 5, the twelfth rib and lesser diaphragm; 7, the right pleura costalis, adhering to the ribs; 8, 9, the two lobes of the left lung; 10, 10, interlobular fissures; 11, the left pleura, forming the walls of the posterior mediastinum: 12, 12, its reflections over the diaphragm on this side; 14, 14, the left pleura costalis on the walls of the chest; 15, the trachea; 16, the larynx; 17, the opening of the larynx and the epiglottis cartilage; 18, the root and top of the tongue; 19, 19, the right and left bronchi; 20, the heart, enclosed in the pericardium; 21, the upper portion of the diaphragm, on which it rests; 22, a section of the œsophagus; 23, a section of the aorta; 24, the arteria innominata; 25, the primitive carotid arteries; 26, the subclavian arteries; 27 the internal jugular veins; 28, the second cervical vertebra; 29, the fourth lumbar vertebra.

ANATOMY OF THE LUNGS AND TRACHEA.

The LUNGS are conical organs, one on each side of the chest, embracing the heart, and separated from each other

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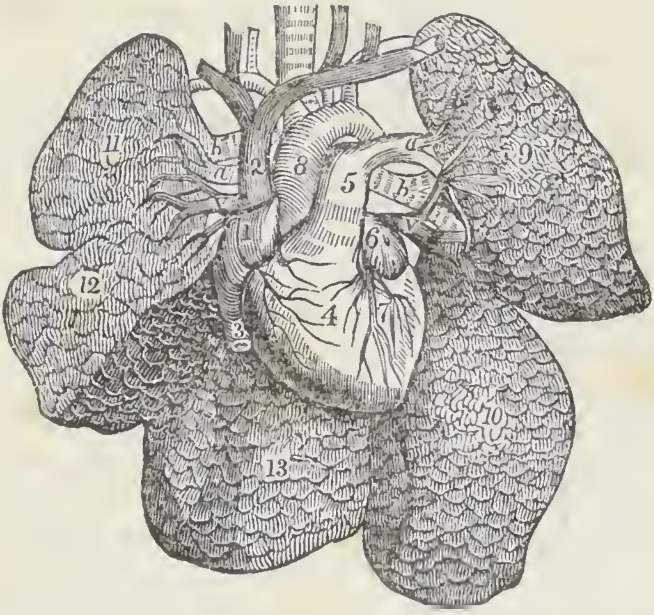
What is the form of the lungs? Where situated?

by a membranous partition, called the *mediastinum.* The color of the lungs is a pinkish gray, mottled and variously marked with black. Each lung is divided into lobes, by a long and deep fissure, which extends from the posterior surface of the upper part of the organ, downward and forward, nearly to the anterior angle of the base. In the right lung, the upper lobe is subdivided by a second fissure. This lung is larger and shorter than the left. It has three lobes, while the left has only two.

Each lung is enclosed, and its structure maintained by a serous membrane, named the *pleura*, which invests it as far as the root, and is thence reflected upon the parietes, or walls of the chest. That part of the membrane which is in relation with the lung, is called the *pleura pulmonalis;* and that part which is in contact with the parietes, the *pleura costalis.*

Fig. 99.



'The above view exhibits the heart and lungs removed from the chest, and the lungs freed from all other attachments. They are arranged so as to show the parts with greater accuracy. 1, the right auricle of the heart; 2, the superior vena cava; 3, the inferior vena cava; 4, the right ventricle; 5, the pulmonary artery issuing from it; *a*, *a*, the pulmonary artery (right and left) entering the lungs; *b*, *b*, bronchi, or air tubes entering the lungs; *v*, *v*, pulmonary veins issuing from the lungs; 6, the left auricle; 7, the left ventricle; 8 the aorta; 9, the upper lobe of the left lung; 10, its lower lobes; 11, the upper lobe of the right lung; 12, the middle lobe; 13, the lower lobe.'

Their color? How is each lung divided? Are the number of lobes equal in each lung? What is the office of the pleura? What is that portion called which covers the lungs? That which is in contact with the ribs?

The two reflected pleuræ in the middle of the thorax, form a partition, which divides the chest into two cavities. This septum is called the *mediastinum.*

The lungs are composed of the ramifications of the bronchial tubes, which terminate in the bronchial cells (*air cells*) of the divisions of the pulmonary artery and veins, bronchial arteries and veins, lymphatics, and nerves. All of these are held together by cellular tissue, which constitutes the *parenchyma.*

Each lung is retained in its place by its *root*, which is formed by the pulmonary artery, pulmonary veins, and bronchial tubes, together with the bronchial vessels, and pulmonary plexus of nerves.

The LARYNX, from the Greek *larugx*, a whistle, is situated at the anterior part of the neck, between the trachea, or wind-pipe, and the base of the tongue. Its body is composed of cartilages, bound together by ligaments, and moved by small muscles. It has blood-vessels, nerves, and a mucous membrane.

The TRACHEA, from *aer*, air, and *terein*, to keep, sometimes called the *wind-pipe*, extends from the larynx, of which it is a continuation, to the third dorsal vertebra, where it divides into two parts, called *bronchi.* It lies immediately anterior of the spinal column, from which it is separated by the œsophagus. The trachea and bronchi are composed of fibro-cartilaginous rings, connected by a yellow, elastic tissue. Their internal surface is lined with mucous membrane.

The two *bronchi* proceed from the bifurcation of the trachea, to their corresponding lungs. Upon entering the lungs, they divide into two branches, and each branch divides and subdivides, and ultimately terminates in small sacs, of various sizes, from the twentieth to the hundredth of an inch in diameter. So numerous are these bronchial or air cells, that the aggregate extent of their lining membrane in man has been computed to exceed a surface of 20,000 square inches.

How is the thorax divided into two cavities? What other name has the septum? Of what are the lungs composed? What is the parenchyma of the lungs? How is the *root* of the lung formed? Describe the *larynx.* Describe the *trachea.* Of what is it composed? Describe the *bronchi.* With what is it lined? In what do the bronchial tubes terminate? The size of these cells? The extent of their lining membrane?

The small bronchial tubes and cells compose the largest portion of the lungs. These, when once inflated, contain air under all circumstances, which renders their specific gravity much less than water; hence the vulgar term, *lights*, for these organs.

The lungs, like other portions of the system, are supplied with *nutrient* arteries, veins, absorbents, and nervous filaments, from the ganglionic system of nerves, and from the pneumogastric nerve. The muscles that elevate the ribs and the diaphragm receive nervous fibres from a separate system, which is called the *respiratory*.

Fig. 100.

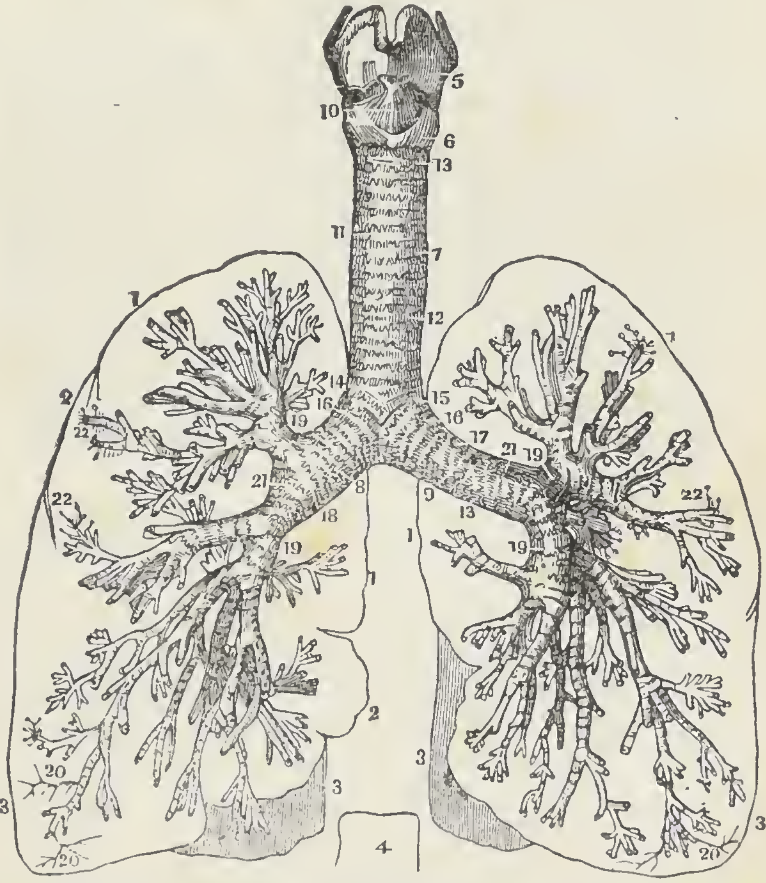


Fig. 100. The larynx, trachea, and bronchia, deprived of their fibrous covering, and with an outline of the lungs. 1, 1, an outline of the upper lobe of the lungs; 2, an outline of the middle lobe of the right lung; 3, 3, an outline of the inferior

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What part of the lung do they compose? What causes the specific gravity of the lungs to be less than water? Have the lungs nutrient arteries? From what system of nerves do the muscles that elevate the ribs receive their nervous fibres? What is the design of fig. 100?

lobe of both lungs; 4, an outline of the ninth dorsal vertebra; 5, the thyroid cartilage; 6, the cricoid cartilage; 7, the trachea; 8, the right bronchus; 9, the left bronchus; 10, the crico-thyroid ligament; 11, 12, the rings of the trachea; 13, the first ring of the trachea; 14, the last ring of the trachea, which is corset shaped; 15, 16, a complete bronchial cartilaginous ring; 17, one which is bifurcated; 18, double bifurcated bronchial rings; 19, 19, smaller bronchial rings. These divide into still smaller tubes, which terminate in small air sacs. These are represented in different parts of the engraving.

PHYSIOLOGY OF RESPIRATION.

Respiration, or breathing, consists in inhaling air into the lungs and expelling it from them. At each act of inspiration, certain muscles, called *respiratory*, elevate the ribs, while the central portion of the diaphragm is depressed by the contraction of its muscular portion, and the increase of the diameter of the chest. The abdominal muscles relax, and the abdomen becomes more protruded, simultaneously with the elevation of the ribs and depression of the diaphragm. The movement of the ribs and diaphragm enlarges the thoracic cavity, and causes a comparative vacuum in the lungs; the equilibrium is restored by the air which is forced by atmospheric pressure into the bronchial tubes and cells.

In expiration, the ribs are depressed by the contraction of the abdominal muscles, the diaphragm relaxes, and its central portion is forced upward. This contracts the cavity of the chest, and diminishes the volume of the lungs, causing the expulsion of the air contained in the air cells.

From the right side of the heart, the impure venous blood is conveyed into the lungs, through the *pulmonary artery*. This artery divides and sub-divides, until the vessels become so small as to resemble hairs in size; hence, they are called *cpaillary*, or hair-like vessels. These small vessels ramify over the thin walls of the air cells. Here the blood, which is impelled from the heart into these minute tubes, is separated from the air, by the thin walls of the air cells, and coats of the capillary vessels.

At this point, the air in the cells, acting upon the blood in the capillary vessels, changes the dark venous blood to

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Define respiration. What change in the position of the organs of the thorax when we inspire air? Describe the change of the thoracic organs during expiration. What is the name of the artery that conveys the venous blood to the lungs? What is said of the subdivisions of this artery? At what point does the venous blood assume a vermillion color?

a bright red, or vermillion hue. It is then returned, through another set of vessels, named *pulmonary veins*,* to the left side of the heart.

Fig. 101.

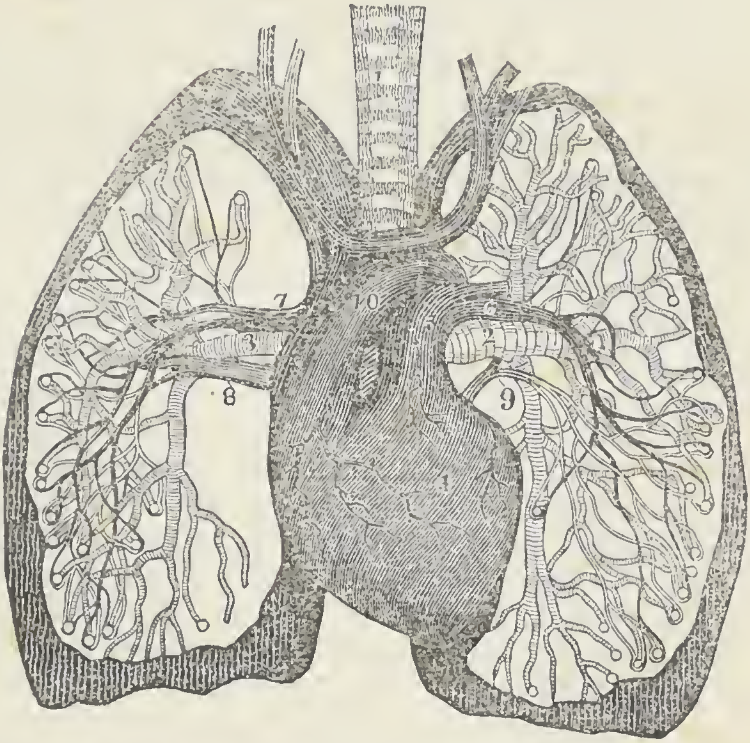

Fig. 101. 1, the trachea; 2, the right bronchus; 3, the left bronchus; 4, the heart; 5, the pulmonary artery; 6, its branch to the right lung; 7, its branch to the left lung; 8, the right pulmonary vein; 9, the left pulmonary vein; 10, the aorta. The bronchial tubes terminate in vesicles.

Air from the trachea, 1, enters the bronchi, 2 and 3. Through these branches it passes to the vesicles at their extremities. The branches of the pulmonary artery, 5, and 6, pass over the bronchial vesicles. Here the dark blood sent from the right side of the heart is purified; it is then returned through the small vessels that unite to form the pulmonary veins, 8, and 9, to the left side of the heart. The bronchus, 5, in this cut, should be represented above 7, the left pulmonary artery.

As the inhaled air is the effective agent in converting venous blood into arterial, its chemical analysis is given. On examination it is found to consist of two gasses,

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* All the tubes or canals that convey blood *from* the heart, are named *arteries*, while those that convey blood *to* the heart, are called *veins*. The name of artery or vein has no reference to the color of the blood which flows through it.

Through what vessels is the arterial blood returned to the heart? What is the effective agent in converting venous into arterial blood?

oxygen and *nitrogen*, or *azote*. They are mixed, in the atmospheric air, in the proportion of one fifth of oxygen and four fifths of nitrogen. Combined with these, are a small proportion of carbonic acid, and also the effluvia of flowers.

The venous blood contains carbonic acid gas, which gives it a blackish red color. When this impure blood passes over the air vesicles, a portion of the oxygen from the air cells permeates its walls, and the coats of the minute blood vessels, and unites with the venous blood. At the same time, carbonic acid gas leaves the venous blood, passes through the coats of the blood vessels and air cells, and mixes with air. This interchange of products alters the color and character of the blood.

It may be inquired how the exchange of carbonic acid gas and oxygen is effected. Some experiments may elucidate this point. 'Take a glass tube, and tie over one end of it a piece of bladder, or some other membrane; then, having partly filled the tube with a solution of gum or sugar, immerse it, with the end covered with the membrane downwards, in a vessel nearly filled with water. The water will pass from the vessel to unite with the fluid in the tube, and cause it to rise. Reverse the experiment, by putting the sugar solution into the vessel, and the water into the tube, and the water will sink, because the same passage of fluids takes place, but in the opposite direction. Thus we see that there is an affinity, or attraction, between one fluid and another, or, an affinity of one fluid for another.' The pure water not only has an affinity for the sugared, but it passes through the bladder more readily than the other.

Again, put a mixture of water and alcohol into a phial, and leave it uncorked. Both the water and alcohol have a greater affinity for air than for each other. Alcohol has the greatest affinity for the air, and will be diffused through it more readily than the water, when there is no intervening obstacle. But tie a piece of bladder over the

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What two gases enter into the composition of the atmospheric air? In what proportions? What does the venous blood contain? Explain how the carbon of the blood unites with the oxygen contained in the air vesicles. Mention a simple experiment to elucidate this point. Another.

mouth of the phial, and let it stand a few days; the water will leave the alcohol and pass through the membrane. In this experiment, it is demonstrated that, although alcohol has a greater affinity for air than for water, yet that water will permeate a membrane more readily than alcohol. By the aid of these experiments, we shall endeavor to explain the interchange of fluids in the lungs.

The walls of the air vesicles, and coats of the blood vessels, are similar, in their mechanical arrangement, to the membranous bladder in the above-described experiments. The oxygen of the air has greater affinity for venous blood than for nitrogen, and permeates the membranes that intervene between the air and blood, more readily than the nitrogen. The carbonic acid gas has a greater affinity for air than for blood. It will also pass through the walls of the blood vessels and air cells more readily than the blood.

PRACTICAL SUGGESTIONS.

The quantity of pure air supplied to the lungs, should be proportioned to the amount of carbonic acid gas, to be eliminated from the system. This is modified by the exercise, and quantity of food that are taken. The active man demands more air than a sedentary individual, and the gormandizer than a person of abstemious habits.

The quantity of carbonic acid gas actually eliminated from the system, depends on three conditions. 1st. The volume of the lungs. 2d. The movement of the ribs and diaphragm. 3d. The purity of the air.

As the quantity of air inhaled, is modified by the capacity of the respiratory organs, the necessity of ample volume of lungs will be elucidated by the following experiment. Suppose a gill of alcohol mixed with a gill of water, be put into a vessel having a square foot of surface, and over the vessel a membrane be tied, and that the water will evaporate in twenty-four hours. If the surface had been only six inches square, only one-

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To what should the quantity of air supplied to the lungs be proportioned? Why does the man of active habits require more air than one of sedentary habits? The gormandizer than one of abstemious habits? How many conditions are given for the actual elimination of carbonic acid gas from the system?

fourth of the water would have evaporated through the membrane in the given time. If the surface had been extended to two square feet, the water would have evaporated in twelve hours. Apply this principle to the lungs: suppose there are two hundred cubic feet of carbonic acid gas to be carried out of the system every twenty-four hours. This gas, in that time, will pass through a membrane of vesicular surface of two thousand square feet. If the lungs were diminished in size, so that there would be only one thousand square feet of vesicular membrane, this amount of gas could not, and would not be eliminated from the system. Under such circumstances, the blood would not be purified. Again: suppose the two thousand square feet of membrane would transmit two hundred cubic feet of oxygen into the system every twenty-four hours. If it should be diminished one half, this amount of oxygen would not pass into the blood. From the above illustrations, we may learn the importance of having well-developed chests, and voluminous lungs, for, by increasing the size of the lungs, the oxygen is supplied to the blood more abundantly, and it is more perfectly deprived of its carbonic acid gas.

The chest of the child or adult, when properly formed, may be contracted by compression, and thus the size of the lungs be reduced. This may be effected by the *moderate* and *constant* pressure of the apparel, over the yielding cartilages and ribs, particularly in infancy. For want of physiological knowledge of the pliant character of the cartilages and ribs in infants, too many mothers, unintentionally, contract their chests, and thus sow the seeds of disease by the close dressing of their offspring.

If this slight but steady pressure be continued from day to day, and from week to week, the ribs will continue to yield more and more, and, after the expiration of a few months, the chest will become diminished in size. This will be effected without any suffering of a marked character; but the general health and strength will be impaired. It is not the violent and ephemeral pressure,

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Give the experiment that elucidates the necessity of ample volume of the lungs. Can the chest of an adult be contracted? How effected? Which is most easily contracted, the chest of an adult or that of a child? Why? What is the consequence of diminishing the size of the chest? Is the contracted chest produced in a day?

but the moderate and protracted, that produces the 'genteel,' contracted chests.

The style of dress which at the present day is almost universal, is a prolific cause of this deformity. These baneful fashions are copied from the periodicals so widely circulated, containing a 'fashion plate' of the 'latest fashions' from Paris. In every instance, the contracted, deformed, and, as it is called, 'neat, lady-like waist,' is portrayed in all its 'fascinating loveliness.' These periodicals are found on every centre table, and exercise an influence almost omnipotent. If the plates which corrupt the morals are excluded by civil legislation, with the same propriety ought not those to be suppressed that have a tendency to induce a course of conduct so adverse to health?

Fig. 102.

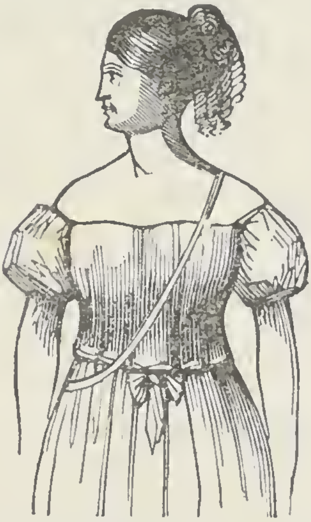

Fig. 103.

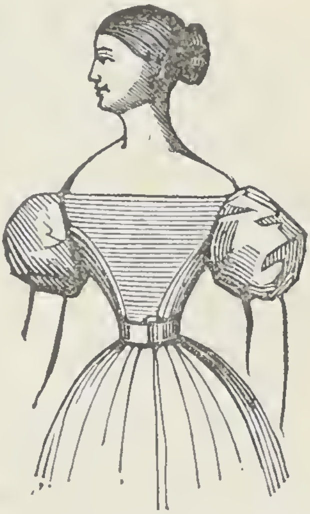

Fig. 102 represents the form which all ladies should possess, while fig. 103 is an illustration of the form that some exhibit.

The thorax is not only most expanded at its lower part, but the portion of the lungs that occupies this space of the thoracic cavity, contains the greater part of the air-cells. Hence, from the lower two-thirds of the lungs, the greatest amount of carbonic acid gas is abstracted from the blood, and the greatest amount of oxygen gas is conveyed into the blood. For this reason, contracting the

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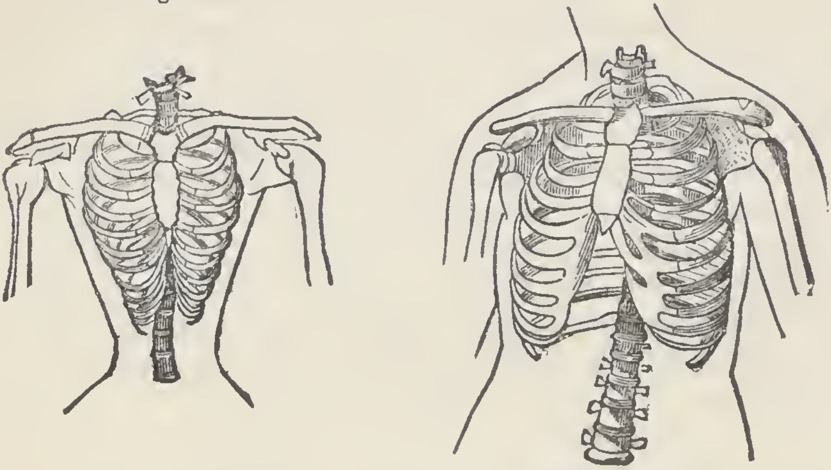
What is said in regard to the style of dress at the present time? Where is the cavity of the thorax most expanded? Where are the greater part of the air-cells situated?

lower ribs is far more injurious to the health, than diminishing the size of the upper part of the chest.

Skeletons of a well-formed female chest, and a contracted one.

Fig. 104. Fig. 105.



'By comparing the accompanying plans of a well-developed and naturally-proportioned female chest, with the frightful skeleton exhibited in figure 104, the difference is strikingly apparent. Here is breadth, space for the lungs to act in, and the short ribs are thrown outwardly, instead of being curved and twisted towards the spine, by which ample space is afforded for the free action of all those organs, which in the other frame were *too small to sustain life.* Fig. 104 may be regarded as the exact shape and figure of a short-lived female; and 105 may be contemplated as an equally true model of the frame of another, who, so far as life depends upon a well-formed body, would live to a good old age.

'Fig. 104. An outline is here presented of a female, to show the condition of the bones, as they appear after death, in every woman who has habitually worn stays. All the false ribs, from the lower end of the breast bone, are unnaturally cramped inwardly towards the spine, so that the liver, stomach, and other digestive organs in the immediate vicinity, are pressed into such small compass that their functions are interrupted, and, in fact, all the vessels, bones, and viscera, on which the individual is constantly depending for health, are more or less distorted and enfeebled.'

The question is often asked, can the size of the chest, and the volume of the lungs, be increased, when they have been injudiciously compressed, or have inherited this unnatural form? The answer is in the affirmative. The means for attaining this end, are, a judicious exercise of the lungs, by walking in the open air, reading aloud, singing, sitting erect, and fully inflating the lungs at each act of inspiration. If the exercise be properly managed and persevered in, it will expand the chest, and give tone and health to the important organs contained in it. But if the exercise be ill-timed or carried to excess, the beneficial results sought for will be defeated.

As the quantity of air inhaled at each unimpeded inspiration is from twenty to forty cubic inches, in lungs of ample size, if the movement of the ribs and diaphragm be restricted, the blood will not be perfectly oxydated. In the former experiment, suppose twenty cubic inches of air must pass over the membrane twenty times every minute, and that this is the amount required to remove the vapor which arises from the membrane; if only half of this amount of air be supplied each minute, only one half as much water will be removed from the alcohol through the membrane in twenty-four hours; consequently, the alcohol would be impure, from the water not being entirely removed.

Fig. 106.

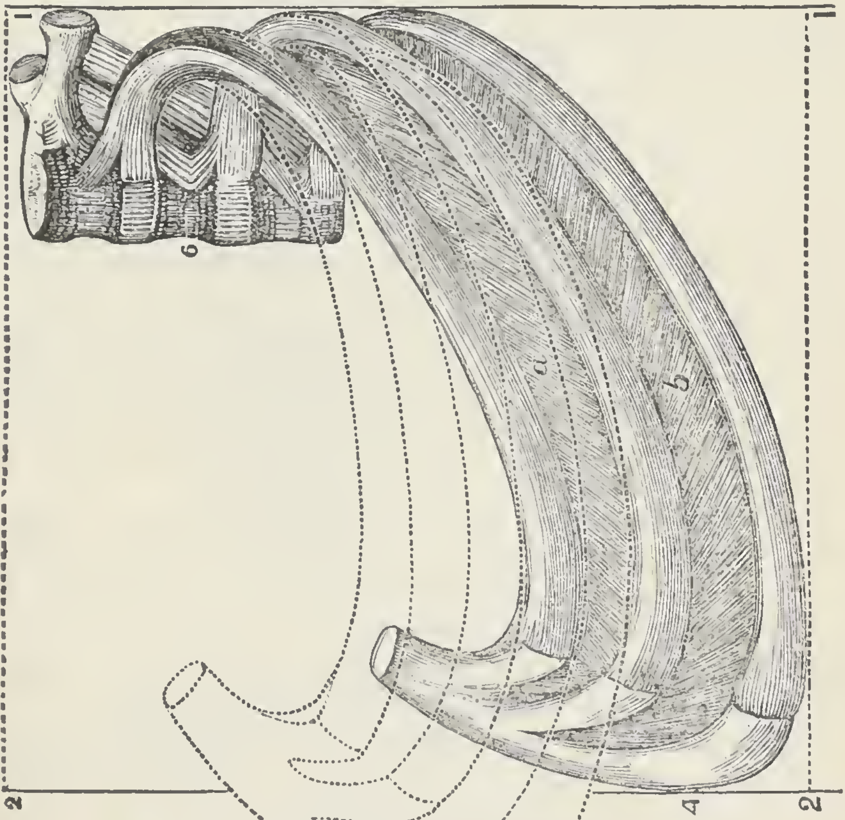


Fig. 106. 6, Two of the vertebræ, to which are attached three ribs, with their intercostal muscles, *a* and *b*. These ribs, in their natural position, have their anterior extremity at (4,) while their posterior part is at 6. 1, 1, and 2, 2, Two parallel lines, within which the ribs lie in their natural position. If the anterior extremity of the ribs be elevated from 4 to 5, they will not lie within the line 2, 2, but will reach to the line 3, 3. If two bands extend from 1, 1, to 2, 2, they will effectually prevent the elevation of the ribs from 4 to 5, as the line 2, 2, cannot be moved to 3, 3.

What will be the effect upon the blood if the movements of the ribs and diaphragm are restricted?

Restrain the elevation of the ribs, and depression of the diaphragm, so that the quantity of air conveyed into the lungs will be reduced to ten cubic inches, when twenty are needed, and the results will be as follows; only one half of the carbonic acid will be eliminated from the system, and the blood will receive but one half as much oxygen as it requires. This fluid will then be imperfectly oxydated, and partially freed of its impurities. The impure blood will be returned to the left side of the heart, and the whole system will suffer from an infringement of organic laws.

As the position and movement of the ribs and diaphragm are not generally understood, and as this is attended with injurious effects in the application of clothing, attention is invited to figs. 20, 34, 96, and 105. It will be seen, that the ribs are attached to the bodies of the vertebræ, and that they pass obliquely around the chest, and make their attachment much lower at the anterior than at the posterior extremity; and also, that the central curved portion of the ribs is lower than even their anterior extremity. The lower ribs have this curved form to a greater degree than the upper. As such is the relation of the ribs to the vertebræ and sternum, the latter cannot be elevated while the spinal column is stationary, without elevating the anterior extremity of the ribs, which enlarges the thoracic cavity.

The lower boundary of the thoracic cavity is formed by the diaphragm. This is attached, at its margins, to the lower extremity of the sternum, the cartilages and extremities of the seven lower ribs, and to some of the lumbar vertebræ. The diaphragm is convex on its upper surface, and extends into the cavity of the chest.

The extension of the diameters of the lower part of the chest, by the elevation of the ribs and sternum, depresses the convexity of the diaphragm, and this depression is still farther increased by the action of its muscular margin, which contracts simultaneously with the muscles that elevate the ribs and sternum. The simultaneous action of these muscles and diaphragm, results from their

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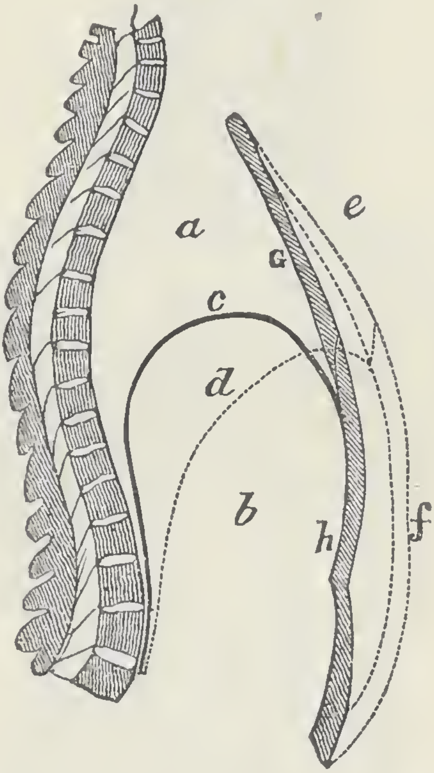
Show how the blood is imperfectly oxydated by restricting the movement of the ribs and diaphragm. How is the lower portion of the thoracic cavity bounded? What depresses the convexity of the diaphragm? How is the convexity further increased? How is the simultaneous action of the intercostal muscles and diaphragm accounted for?

being supplied with nervous filaments from the same system of nerves. While the central portion of the diaphragm is depressed, the abdominal muscles are relaxed, and the abdominal viscera are depressed, which produces an increased projection of the abdominal walls and organs.

Fig. 107.



a, The cavity of the chest; *b*, the cavity of the abdomen; *c*, the line of direction for the diaphragm when relaxed in expiration; *d*, the line of direction for the diaphragm when contracted in inspiration; *g*, *h*, the position of the front walls of the abdomen and chest in expiration; *e*, *f*, the position of the front walls of the chest and abdomen in inspiration.

The chest can be prevented from expanding, by extending a band from one of the ribs to its fellow opposite; or by extending a band from its attachment to the sternum, to its vertebral extremity. Either will effectually antagonize the contractile efforts of the respiratory muscles to elevate the sternum or depress the diaphragm.

Let a tense band extend from a lumbar vertebræ to

What is the effect upon the abdominal viscera when the diaphragm is depressed? How can the chest be prevented from expanding? Illustrate it by fig. 107.

the abdominal muscles, when the diaphragm is at *c*, (fig. 107,) and the abdominal muscles at *h*, and it will prevent the descent of the diaphragm to *d*, by restricting the movement of the muscles at *h*, from assuming their position at *f*.

Fig. 108.

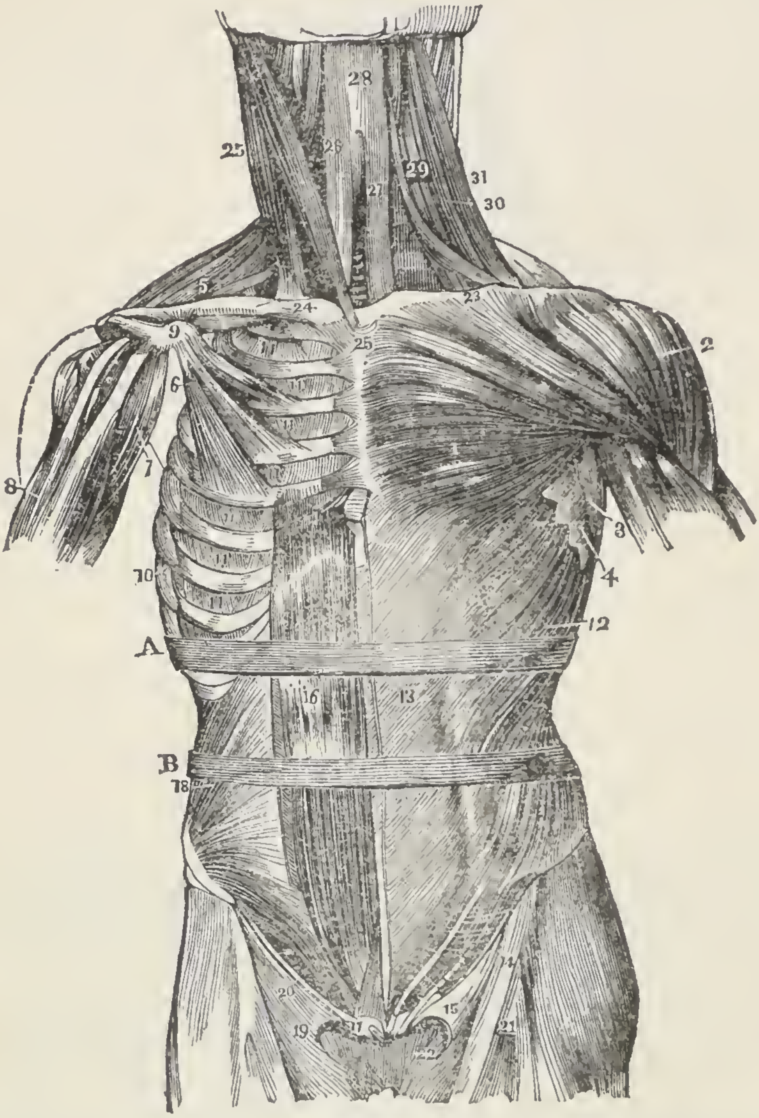


Fig. 108. 6, represents the pectoralis minor muscle; 10, serratus magnus; 25, sterno mastoid; 26, sterno hyoid; 27, sterno thyroid; 28, thyro-hyoid; 29, omo-hyoid; 30 and 31, scalenus anticus and posticus. These several muscles, by their contraction, elevate the sternum and anterior extremity of the ribs. The muscles 11, 11, 11, 11, 11, 11, 11, intercostals, by their contraction, elevate the central portion of the ribs. The belt A will prevent the elevation of the sternum and ribs as before explained. The belt B not only prevents the upward movement of the ribs, but will prevent the muscles 12, external oblique, 6, rectus, 18, transverse, from becoming protuberant in inspiration, which effectually obstructs the descent of the diaphragm.

Any inelastic band drawn closely around the lower part of the chest or the abdomen, below the ribs, operates like the bands in the preceding illustration, in restricting the movement of the ribs. When the diameter of a circle is increased, there is also a corresponding increase of the circumference. The unyielding band prevents an extension of the circumference of the chest or abdomen, and consequently, the diameter or capacity of the chest cannot be increased. When any article of dress encircles either the thorax or abdomen, so as to prevent an increase of its circumference, it has an injurious tendency, as it precludes the introduction of air in sufficient quantities to purify the blood. The question is not,—how much restriction of the respiratory movements can be endured, and life continue? but,—does any part of the apparel restrict these movements? If it does, it is a violation of the organic laws, and though nature is profuse in her expenditures, yet sooner or later she sums up her account.

In determining whether the apparel is worn too tightly, inflate the lungs, and, if no stricture or pressure is felt, no injurious effects need be apprehended from this cause. In testing the closeness of the dress, some persons will contract to the utmost the abdominal muscles, and thus diminish the size of the chest, by depressing the ribs; when this is effected, the individual will exclaim, 'How loose my dress is!' This practice is both deceptive and ludicrous. A full inflation of the lungs is a proper test.

If the brain be depressed by grief, tormented by anxiety, or absorbed in abstract thought, the contractile energy of the diaphragm and muscles that elevate the ribs, is much diminished, and the lungs are not so fully inflated as in a different condition of the cerebral organ. The frequency of respiration is also much less. By the influence of these two causes, the blood is but partially purified, and the whole system becomes enfeebled. This is not unfrequently followed by the deposition of tuberculous matter in different parts of the system, and the individual eventually dies of scrofula or consumption.

Do all inelastic bands drawn closely around the lower part of the thorax operate in the same manner? What is the effect? How can we determine whether our apparel is too tightly worn? What is the effect when depressed by grief? Does the state of the brain exert an influence on respiration? What is the ultimate result?

This is exemplified in those individuals who have met with reverses of fortune, in which character and property were lost. Hundreds yearly go to their spirit-homes from the effect of depressed spirits. A striking instance is related by Lænnec. In a female religious establishment in France, great austerities were practised; the mind was absorbed in contemplating the terrible truths of religion, and in mortifying the flesh. The whole establishment, in the space of ten years, was several times depopulated, — with the exception of the persons employed at the gate, in the kitchen and garden, — with that fatal disease, consumption. This institution did not long continue, but was suppressed by order of the French government.

Respiration is more frequent in females and children than in adult men. In diseases, particularly those of the lungs, it is more increased in frequency than the action of the heart. In a state of rest, the number of respirations in a healthy man, are from fourteen to eighteen in a minute. Usually the heart beats about four times to every respiration.

If a person respire sixteen times every minute, and inhale each time twenty cubic inches of air, there would be needed, to supply his wants, 518,400 cubic inches of air, or 300 cubic feet, every twenty-four hours.

During the interval of respiration, the change of the blood is still progressing in the lungs, as there is always a quantity of air remaining, which is called *residual* air. The inhaled air should contain one fifth part of oxygen. At every inhalation, a portion of the oxygen permeates the vesicular membrane and unites with the blood, which at the same time emits a certain amount of carbonic acid gas, which unfits the air to be respired a second time.

A simple experiment will elucidate the vitiation of exhaled air. Breathe into a cup containing lime-water, and in a short time a white pellicle will be seen on the surface of the water. This is called the carbonate of lime,

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Give the instance related by Lænnec. In whom is respiration most frequent? How is it in diseases? How often do we respire in a minute? How often does the heart beat at every respiration? How many cubic feet of air do we inhale in twenty-four hours? How much oxygen should the inhaled air contain? Why? Why is air unfit to be re-inhaled? How can it be proved that the air exhaled contains carbonic acid gas?

and this alkaline salt is formed by the carbonic acid gas from the exhaled air uniting with the lime.

It is a well-known fact, that a taper will not burn where carbonic acid alone exists; and another proof that exhaled air contains carbonic acid gas, or will not support combustion, may be seen by the following experiment.

Take a glass receiver, to which is attached a stop-cock; sink it in water until it displaces the air by filling the receiver. Gradually raise it, and respire into it, avoiding as much as possible the ingress of atmospheric air; then inhale the same air, and sink the vessel into the water. Repeat this several times. Fill the receiver with the air that has been inhaled several times, and slide a plate under it while the open mouth of the receiver is kept below the surface of the water. By turning the stop-cock, and keeping it on the plate filled with water, no atmospheric air will pass into the receiver. After a taper is lighted, raise the jar suddenly, and pass the burning taper into it; the flame will be immediately extinguished, for want of oxygen to support combustion, and in consequence of the presence of carbonic gas.

In crowded rooms, which are not ventilated, the air is soon vitiated by the abstraction of oxygen and the deposition of carbonic acid gas, by the audience. The lamps, under such circumstances, emit but a feeble light. Let the oxygen gas be more and more expended, and the lamps will burn more and more feeble until nearly extinguished. Air in which lamps will not burn with brilliancy, is unfitted for respiration. For this reason, before entering wells or subterranean passages, a lighted taper should be passed into them, and if the flame be extinguished, it shows the presence of carbonic gas, and if such places are entered before this deleterious gas is removed, instant death will follow. Nor should persons sleep in rooms where charcoal is in a state of ignition, without some aperture to permit the carbonic acid gas to escape.

In addition to the above-named sources, which render the air unfit for respiration a second time, there is passing from the skin and lungs more than two pounds of waste matter every twenty-four hours. This is diffused through

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What experiment shows that exhaled air will not support combustion? What effect has vitiated air upon burning lamps? What caution is given on entering subterranean passages? In sleeping in a close room where ignited charcoal is placed?

the air in the room, and if this impure air be not changed, it will be inhaled into the lungs.

Let the air become vitiated, whether from the abstraction of oxygen, an excess of carbonic gas, or the exhalations from the lungs and skin, and it will have a deleterious effect upon the system, by rendering the circulating fluid impure. For this reason, in workshops, churches, and dwelling houses, pure air should be admitted freely and constantly, and the impure and vitiated air permitted to escape. This is of more importance than the warming of houses. We can compensate for the deficiency of a stove, by an extra garment or an increased quantity of food; but neither garment, exercise, or food, will compensate for pure air.

The brain of the scholar must be stimulated by pure blood, or its proper functions will not be performed. If the school-house be not ventilated, the pupils will complain of inability to study, defective memory, and headache, caused by a want of pure oxygenated blood, and an excess of carbonic acid gas.

Above all, the sleeping room should be so ventilated that the air, in the morning, will be as pure as when retiring to rest in the evening. Ventilation of the room would prevent morning headaches, and the want of appetite, so common among the feeble. *Every* room should be so constructed that pure air can be admitted freely, as all obstructions tend to weaken and destroy the system. The impure air of sleeping rooms is probably more ruinous than intemperance. Look around the country, and those who are most exposed, who live in huts but little superior to the sheds that shelter the farmer's flocks, are found to be the most healthy and robust. Headaches, liver complaints, and coughs, are almost unknown to them; not so with those who spend their days and nights in rooms, in which the sashes of the windows are caulked, or perchance doubled, to prevent the keen but healthy air of winter from entering their apartments. Disease and suffering are their constant companions. The one breathes pure air; the other does not.

Is the ventilation of rooms of as much importance as the warming of them? Why should every inhabited room be well ventilated?

Due attention has not been given to the proper ventilation of rooms. 1st, air can and should be introduced into our apartments *pure* and *warm*. This can be effected by procuring a 'self-ventilating stove.' 2d, provision should be made for the escape of the vitiated air, as well as the introduction of pure air. This can be done by constructing a ventilating flue in the chimney. This should be in contact with the flues for the escape of smoke, but separated from them by a thin brick partition. The heat of the current of air in the smoke flues will warm the separating brick partition, and consequently rarefy the air in the ventilating flue. Communication from every room in a house should be had to such flues. The draught of air can be regulated, by well-adjusted registers.

Effects of impure blood upon the system will now be stated. The blood may be rendered impure by each of the influences before described, or by all of them combined. We will note the effect it has upon the bones. As one condition of health and strength, they require pure blood. If it be not supplied to them, they will become soft and brittle; their vitality will be impaired; disease will be the ultimate result. The four hundred muscles receive another portion of the blood. These organs are attached to, and act upon the bones. Upon the health and contractile energy of the muscles depends the ability to labor. Give these organs of motion impure blood, which is an unhealthy stimulus, and they will become enfeebled, the step will lose its elasticity, the movement of the arm will be inefficient, and every muscle will be incapacitated to perform its usual amount of labor.

The stomach, liver, and other organs subservient to the digestion of food, are supplied with this unoxydated blood. This impairs the digestive process, causing a faintness of the stomach, loss of appetite, and a deranged state of the intestines. The person has the reputation of being troubled with the dyspepsia, or liver complaint. Another portion goes to the lungs in the *nutrient* arteries. The delicate structure of these organs, in which the blood is, or should be purified, needs the requisite amount of pure blood to give them vigor and health. The blood not be-

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How should pure air be introduced into apartments? How should the impure air be carried from rooms? Mention how impure blood affects the bones and muscles of the system. The digestive organs.

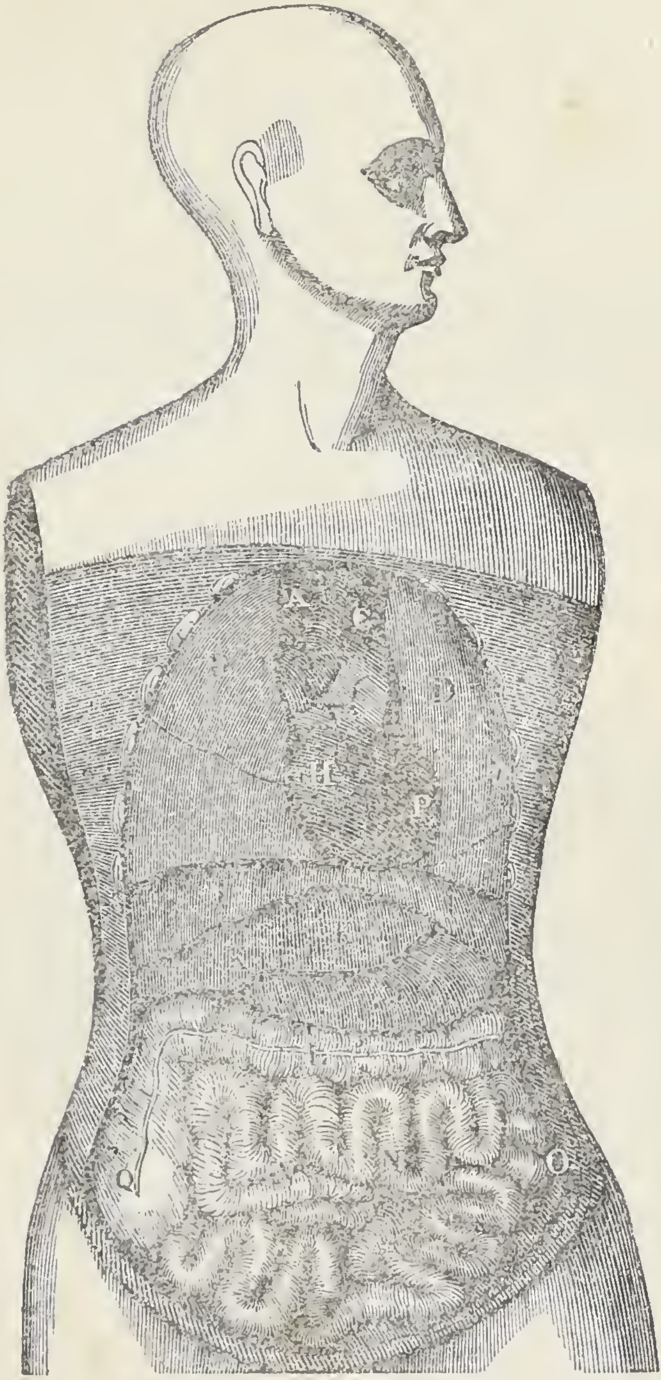
ing of that character, the lungs themselves lose their tone, and the inability to purify the blood ceases in a little time, even if permitted to expand freely. This dark, sluggish blood also passes to the skin, the health and beauty of which require well-oxygenated blood. This not existing, the surface becomes covered with pimples and blotches, and the individual suffers from 'humors,' as they are called. Drinks made of various kinds of herbs, and pills and powders, are taken for this disease. These will have but little effect while the causes of impure blood exist.

This impure blood is sent to the brain. If this important organ be stimulated by impure blood, the nervous headache, bilious headache, and all kinds of aches, confusion of ideas, loss of memory, impaired intellect, dimness of vision, and dulness of hearing, attend on this impure stimulus. Often, in the process of time, the brain becomes disorganized, and the brittle thread of life is broken.

The free movements of the ribs and diaphragm, with an abundant supply of pure air, are of the utmost importance to feeble and scrofulous individuals. A prolific cause of scrofula, so prevalent in the densely-populated sections of our country, arises from the inhalation of vitiated air. Due renovation of the air which we breathe is really influential in protecting us against the inroads of disease. A constant circulation of air is one of the most effectual means of preventing contagion from fever. It is no unusual practice in some communities, when a child or an adult is sick of an acute disease, to prevent the ingress of pure air, simply from the apprehension of the attendants, that the patient will contract a cold. In fevers, or inflammatory diseases of any kind, let the patient have pure air to breathe, for the more perfect the oxydation of the blood, the greater the conservative power of the system, and the less the liability to contract colds.

Fig. 109 represents the thoracic and abdominal organs, in their relative positions. Let the pupil, from this figure, review the sections upon the anatomy and physiology of the digestive and respiratory organs, giving the location of each part, describing its structure, use, and the laws upon which health depends.

Fig. 109.



A, B, C, are large blood vessels, that open into the heart; D, D, the lungs; H, right ventricle of the heart; P, left ventricle of the heart; I, I, the diaphragm; K, K, the liver; J, the stomach; Q, the ascending colon; L, the transverse colon; O, the descending colon; N, N, the small intestines.

CHAPTER VIII.

THE VOICE.

The voice consists in the production of a particular sound, by the aid of the air which escapes from the lungs. It is chiefly formed in that portion of the respiratory organs named the *larynx.* Incidentally, the other portions of the respiratory apparatus are subservient to phonation. The tongue, nasal passages, muscles of the fauces and face, are agents which aid in the intonations of the voice. The mechanism and function of the larynx, will be the topics examined in this chapter.

ANATOMY OF THE LARYNX.

Fig. 110.

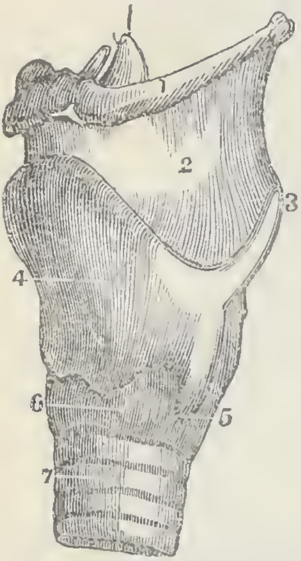


Fig. 111.

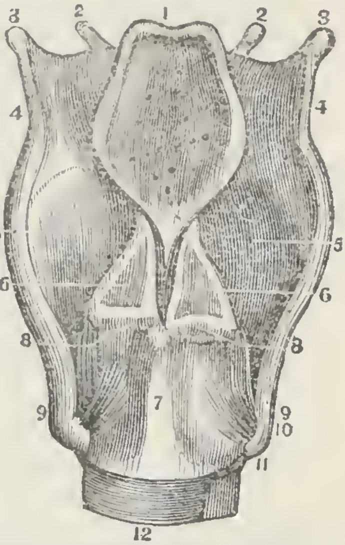


Fig. 110 is a lateral view of the cartilages and ligaments of the larynx. 1, The os hyoides; 2, a ligament which connects the hyoid bone with the thyroid cartilage; 3, the large horn of the thyroid cartilage; 4, the angle and side of this cartilage; 5, the small horn of this cartilage; 6, the lateral portion of the cricoid cartilage; 7, rings of the trachea.

What is the voice? In what organ is it chiefly formed? Name other organs that are subservient to phonation. What do figs. 110 and 111 represent?

Fig. 111 is a posterior view of the cartilages and ligaments of the larynx. 1, the posterior face of the epiglottis; 2, the appendages of the os hyoides; 3, its cornua, or horns; 4, the lateral ligaments which connect the os hyoides and thyroid cartilage; 5, the posterior face of the thyroid cartilage; 6, the arytenoid cartilages; 7, the cricoid cartilage; 8, the articulation of the cricoid and arytenoid cartilages; 9, the posterior ligament that connects the cricoid and thyroid cartilages; 10, the small horn of the thyroid cartilage; 11, the anterior ligament that connects the cricoid and thyroid cartilage; 12, the ligamentous portion of the first ring of the trachea.

The LARYNX is a kind of cartilaginous tube, which, taken as a whole, has the general form of a hollow and reversed cone, with its base upward toward the tongue, in the shape of an expanded triangle. It opens into the pharynx, and at its summit unites inferiorly to the trachea.

The walls of the larynx are chiefly formed by the union of five cartilages, viz: the *thyroid*, *cricoid*, the two *arytenoid*, and the *epiglottis*. These are bound together by ligaments, and moved by muscles.

Fig. 112.

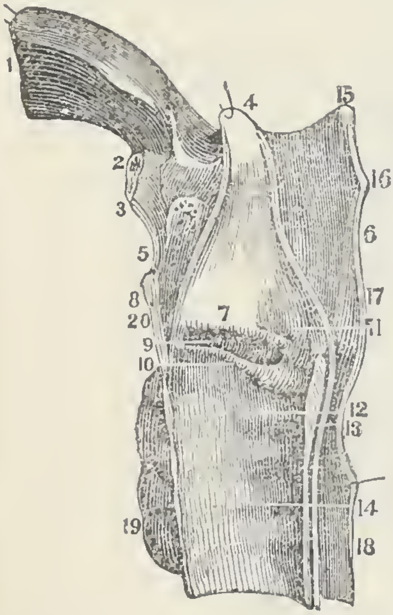


Fig. 113.

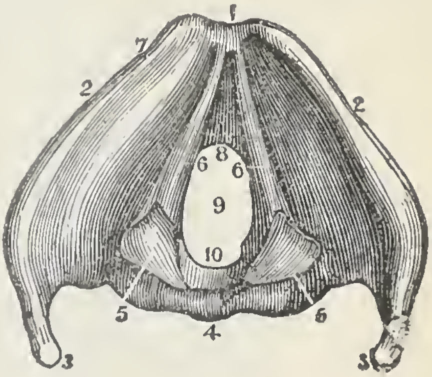


Fig. 112 represents a vertical section of the larynx. 1, a section of the root of the tongue; 2, the os hyoides; 3, the muciparous gland of the epiglottis; 4, the top of the epiglottis cartilage; 5, a section of its anterior face; 6, a fold of mucous membrane; 7, the superior vocal ligament; 8, a section of the thyroid cartilage; 9, the ventricle of the larynx; 10, the lower vocal ligament; 11, the arytenoid cartilages; 12, inside of the cricoid cartilage; 13, its posterior portion; 14, the lining membrane of the trachea; 15, the end of the cornu major of the os hyoides; 16, the cornu major of the thyroid cartilage; 17, the mucous membrane of the pharynx; 18, the œsophagus; 19, the thyroid gland.

Fig. 113 is a view of the larynx from above, showing the vocal ligaments. 1, the superior edge of the larynx; 2, its anterior face; 3, the cornu major of the thyroid

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Describe the *larynx*. How are its walls formed? How are these cartilages bound together and moved?

cartilage; 4, the posterior face of the thyroid cartilage; 5, 5, the arytenoid cartilages; 6, 6, the vocal ligaments; 7, their origin, within the angle of the thyroid cartilage; 8, their termination, at the base of the arytenoid cartilages; 9, the glottis; 10, the anterior part of the inferior surface of the cricoid cartilage.

The *vocal cords*, or ligaments, are formed of elastic and parallel fibres, enclosed in a fold of mucous membrane. They are about two lines in width, and pass from the anterior angle of the thyroid cartilage to the two arytenoid cartilages. The one is named the superior, and the other the inferior vocal ligament. The cavity or depression between the superior and inferior ligament, is named the ventricle of the larynx. The aperture or opening between these ligaments or vocal cords, is named the *glottis*, or *chink of the glottis*. It is about three fourths of an inch in length, and one fourth of an inch in diameter; the opening being widest at the posterior part. This opening is enlarged and contracted by the agency of the different laryngeal muscles.

The cartilages of the larynx have attached to them, and are acted upon by eight pairs of small muscles. Several of these muscles are well represented in the following engravings.

Fig. 114.

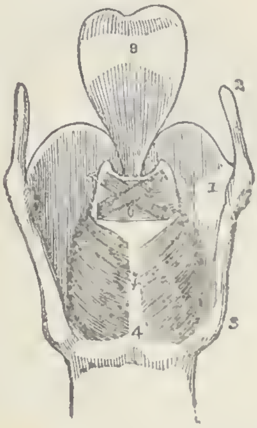

Fig. 115.

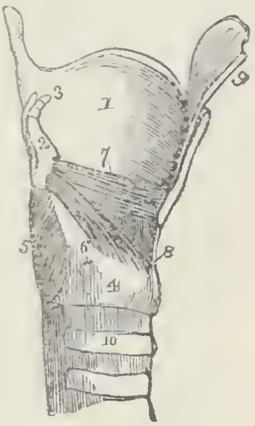

Fig. 114. A posterior view of the larynx. 1, the thyroid cartilage; 2, one of the ascending cornua; 3, one of the descending cornua; 4, the cricoid cartilage; 5, 5, the arytenoid cartilages; 6, the arytenoideus muscle, consisting of oblique and transverse fibres; 7, the crico-arytenoideus-postici muscles; 8, the epiglottis.

Describe the vocal cords. How named? What is the name of the cavity between the superior and inferior ligaments? Where do we find the chink of the glottis? How wide is the glottis? How long? How is this opening enlarged and contracted? How many muscles act upon the cartilages of the larynx?

Fig. 115. A side view of the larynx. 1, the thyroid cartilage; 2, one of the arytenoid cartilages; 3, one of the cornua of the larynx; 4, the crycoid cartilage; 5, the crico-arytenoidus-posticus muscle; 6, the crico-arytenoideus-lateralis muscle; 7, the thyro-arytenoideus muscle; 8, the crico-thyroidean membrane; 9, the epiglottis; 10, the upper part of the trachea.

In fig. 114, the muscle 7 opens the chink of the glottis. The muscle 6 closes the chink of the glottis.

In fig. 115, the muscles 6 and 7 open the chink of the glottis.

The larynx is connected by muscles with the sternum, œsophagus, base of the skull, hyoid bone, lower jaw, and tongue. The two following engravings illustrate this connexion.

In addition to the parts before described, the larynx is supplied with a large number of blood vessels. It likewise receives nerves from the ganglionic system, and two large nerves from the eighth pair. The number and size of the nervous filaments distributed to the mucous membrane of the larynx, render it more sensitive than any other portion of the respiratory passages.

Fig. 116.

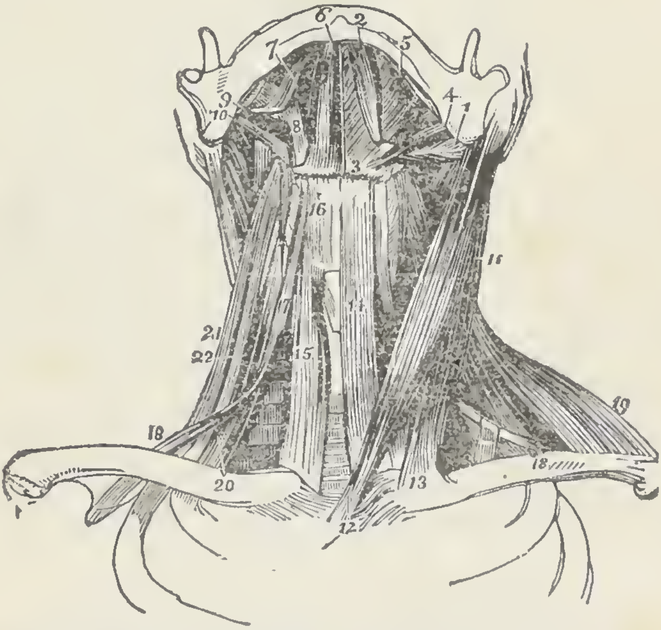

Fig. 116. The muscles of the anterior aspect of the neck. On the left side the superficial muscles are seen; on the right, the deep. 1, the posterior belly of the digastricus muscle; 2, its anterior belly; 3, the os hyoides, to which is attached the pulley, through which the tendon of the digastricus passes; 4, the stylo-hyoideus muscle; 5, the mylo-hyoideus; 6, the genio-hyoideus; 7, the tongue; 8, the hyoglossus muscle; 9, the stylo-glossus; 10, the stylo-pharyngeus; 11, the sterno-mastoid muscle; 12, 13, its sternal and clavicular origin; 14, the sterno-hyoid muscle; 15, the sterno-thyroid; 16, the thyro-hyoid; 17, 18, the omo-hyoid; 19, the trapezius; 20, the scalenus anticus; 21, the scalenus posticus.

With what is the larynx connected? Why is the larynx more sensitive than other parts of the respiratory passages?

The muscles 1, 2, 4, 5, and 6, elevate and draw forward the hyoid bone, when the lower jaw is fixed; or depress the jaw when the os hyoides is fixed. The muscles 11, 14, 15, and 16, elevate the sternum when the os hyoides is fixed, or depress this bone and the larynx when the sternum is fixed. When these two sets of muscles act together, the larynx is projected forward.

Fig. 117.

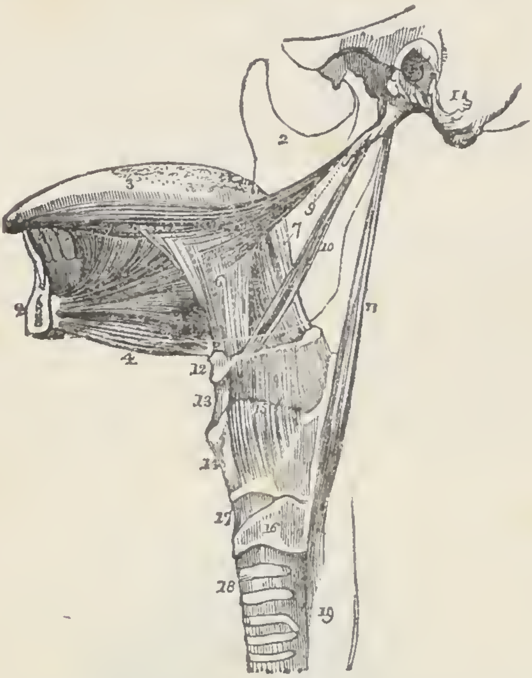

Fig. 117. 1, a portion of the temporal bone of the left side; 2, 2, the right side of the lower jaw; the left side has been removed. The white line shows the position of the jaw behind the muscles; 3, the tongue; 4. the genio-hyoideus muscle; 5, the genio-hyo-glossus; 6, 7, the hyo-glossus; 8, a portion of the lingualis; 9, the stylo-glossus; 10, the stylo-hyoid; 11, the stylo-pharyngeus; 12, the os-hyoides; 13, the membrane connecting the hyoid bone with the thyroid cartilage; 14, the thyroid cartilage; 15, the thyro-hyoideus muscle; 16, the cryeoid cartilage; 17, the membrane which connects the cricoid and thyroid cartilages; 18, the trachea; 19, the commencement of the œsophagus.

The muscle 4, elevates the larynx, and draws it forward, when the under jaw is fixed, or it depresses the under jaw when the larynx is fixed. The muscles 6, 7, elevate the larynx or depress the root of the tongue when the larynx or tongue operates as the fixed point. The muscles 10, and 11, draw the larynx upward and backward. The muscle 9, draws the root of the tongue upward and backward. The muscle 15, draws the larynx toward the hyoid bone, or this bone toward the larynx, as the one or the other is fixed by the action of other muscles.

PHYSIOLOGY OF THE LARYNX.

In the formation of the voice, each of the parts before described performs an important part. The cricoid and thyroid cartilages give form and stability to the organs; the arytenoids by their movement vary the width of the glottis. The epiglottis is flexible and elastic. When it is erect, the chink of the glottis is open, as in inspiration;

Which cartilages give stability and form to the larynx? Which vary the diameter of the glottis? What is the function of the epiglottis?

when depressed, as in swallowing food and drink, it covers and closes this aperture. This prevents the introduction of articles of food into the air-passages, and, probably, modifies the sounds as they issue from the glottis.

The muscles of the neck elevate and depress the larynx; the laryngial muscles increase or diminish the width of the glottis; at the same time, the vocal cords which vary the vocal sounds, are relaxed or rendered tense.

It is now proved beyond a doubt that the vocal cords are the principal agents in the formation of the voice. The tongue, which many have supposed to be the most important organ in phonation, is not essential to sound, as in some cases of the removal of the tongue, the persons thus mutilated could speak with fluency.

Sound depends on the forcible ejectment of air from the chest, through the chink of the glottis. The velocity of the expelled current of air, and the tension of the vocal ligaments are the principal circumstances that modify the character of sound. The size of the larynx, the volume and health of the lungs, the condition of the fauces and nasal passages, the elevation and depression of the chin and tongue, the developement and freedom of action of the muscles which connect the larynx with the sternum, hyoid bone, lower jaw and tongue, contribute to the modulations of sound.

The developement of the vocal apparatus, the education and use of the vocal organs, will be the subject of the following suggestions.

PRACTICAL SUGGESTIONS.

The larynx is much more developed and prominent in man than in woman. In the former, the retreating angle of the thyroid cartilage is acute, while in the latter, it is rounded, and the central slope of the superior border of the same cartilage is less deep, and the epiglottis smaller and less prominent than in man.

Less striking difference exists in the formation of the larynx in infancy, but at a later period it is more devel-

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By what means are the vocal sounds varied? What are the essential agents in phonation? Is the tongue essential in phonation? On what does sound depend? What difference between the formation of the larynx of the female and that of the male? Does this difference exist in childhood?

oped in the male than in the female. It is very remarkable, that this increase is not progressive, like that of the other organs, but, on the contrary, developes itself at once at the period of puberty.

Common observation shows, that the voice can be changed and modified by the habits; sailors, smiths and others, who are engaged in noisy occupations, exert their vocal organs more strongly than those of more quiet pursuits. This not only affects the structure of the vocal organs, but varies their intonations.

Fig. 118.

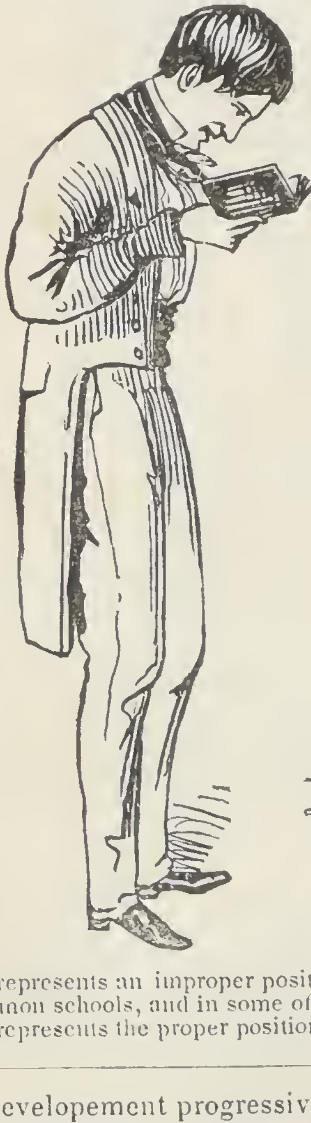


Fig. 119.

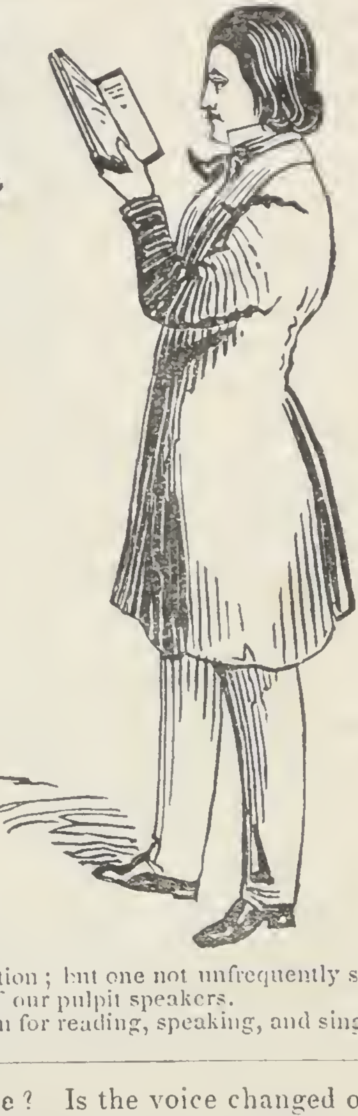


Fig. 118 represents an improper position; but one not unfrequently seen in some of our common schools, and in some of our pulpit speakers.

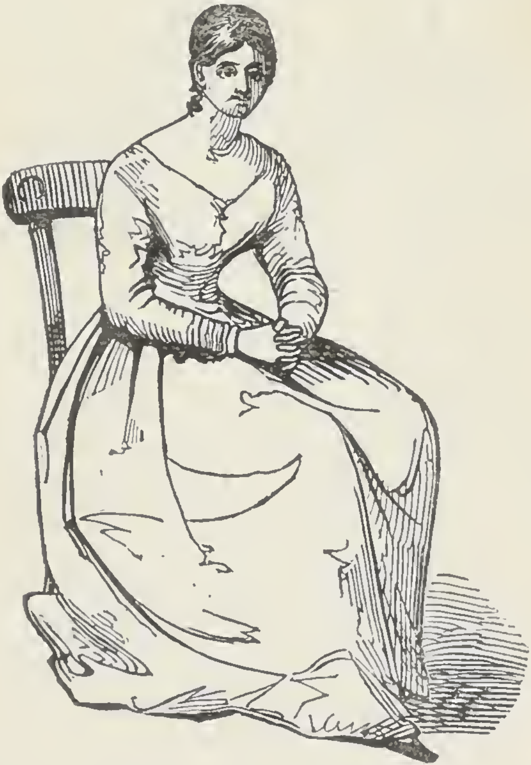
Fig. 119 represents the proper position for reading, speaking, and singing.

Is its developement progressive? Is the voice changed or modified by habits? Give an instance. What is the effect? What do Figs. 118 and 119 exhibit?

The voice is strong in proportion to the development of the larynx, and the capacity of the chest. This points to the necessity, not only of exercising the larynx, chest, and upper part of the abdomen, but also of dressing loosely.

The attitudes also affect the modulation of the voice. When an individual stands erect, the movements of the whole respiratory apparatus are most free and effective. The larynx is brought forward by the erect position of the head, and elevation of the chin; this is effected by the tension of the muscles that connect it with the lower jaw and sternum. The laryngeal muscles are then brought to a proper relation for action, by which a tension of the vocal cords is produced, that favors clear and harmonious enunciation. Hence, children and adults should stand or sit erect in speaking, reading or singing.

Fig. 120.



If an individual or class, read or sing, when sitting, let the position represented in fig. 121 be adopted, and not the one represented in fig. 120, for the erect position in

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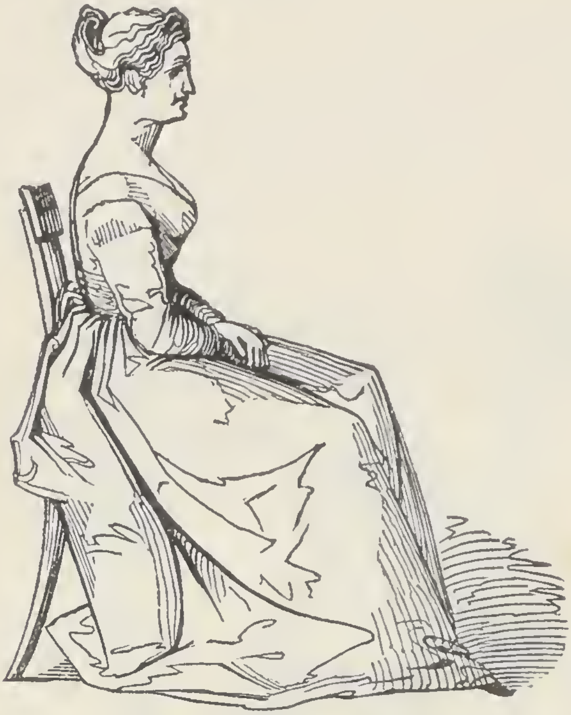
On what does the strength of the voice depend? What does this point to? Have the attitudes any effect on the modulations of the voice? Why is the erect, standing position preferred?

sitting, favors the free and effective action of the respiratory and laryngeal organs, but not in so great a degree as when the erect standing attitude is assumed.

Fig. 121.



As pure air is more elastic and resonant than impure, and as easy, melodious speaking, or singing, requires atmospheric elasticity, so school rooms and singing halls should be well-ventilated, if we would be entertained with soft intonations in reading, or sonorous singing.

The sound of the voice is modified, and enunciation rendered more or less distinct, in proportion as the jaws are separated in speaking, and the fauces and nasal passages are free from obstruction. For these reasons the scholar should be taught to open the mouth, when reading, speaking or singing, that the sounds formed in the larynx, and modified in the fauces, may have an unobstructed egress. If the fauces are obstructed by *enlarged tonsils*, a condition by no means uncommon in children, they should be removed by a surgical operation, which is not only effective, but safe and not painful. These tonsils are situated on each side of the root of the tongue, and when

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What does Fig. 121 exhibit? Give a reason why school houses and singing halls should be well-ventilated. Name another influence which induces clear enunciation.

enlarged they obstruct the passage through which the air passes to and from the lungs, which renders the respiration not only laborious but distressing.

If the muscles of the neck and larynx are compressed by a high cravat, or other close dressing, their movement will be impeded and the power of phonation diminished. Therefore let the clothing of the neck, particularly of *public speakers* and *singers*, be loose. The clothing should be not only loose, but thin, as when the vocal organs are used, a warm dress upon the neck will induce too great a flow of blood to these parts, which will be attended by subsequent debility. The warm and close dressing of the neck, is the most prolific cause of loss of voice, called *bronchitis*,—a disease very prevalent among clergymen.

The varied tones in speaking and singing, are caused by different degrees of tension in the vocal cords, and different conditions of the auxiliary organs. The different conditions of the vocal apparatus are produced by various degrees of contraction of the muscles of the larynx and neck. To induce a state of these muscles suited to produce a certain intonation in speaking or singing, requires practice, or, in other words, education of the muscles. The successful mode of training the vocal organs, is similar to that adopted in learning to dance, or to play the piano. When a child learns to dance, in making the different steps he calls into action certain muscles. At the commencement, these steps are made in a stiff and ungraceful manner. Much effort is also required to assume the different positions. By repetition of the contraction of the muscles, the movements become more ready and graceful, while the labor and effort of dancing are diminished. The same is true in learning to play any musical instrument, or in acquiring skill in the use of tools in mechanical pursuits.

Hence, let there be an effort made to induce a proper state of the vocal organs, to produce a particular sound. Let this effort be repeated again and again for a

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What is the effect of a high cravat, or close dressing of the neck? What is a prolific cause of bronchitis among clergymen and other public speakers? How are the varied tones in singing produced? Must the vocal organs be trained or educated in order to a particular sound? How effected?

short period. After relaxing or resting the organs, call them again into action. Let there be repetition, until all the parts of the vocal apparatus can be called into ready and harmonious action. This repetition is as necessary in learning to read as in singing or writing. In teaching the young child to read, never commence until he can give the proper sound to all the different letters. See that his position is proper, and be careful that the letter, syllable or word, is distinctly and properly enunciated, so that what is learned, is learned rightly. There is nothing gained, in the attempt to instruct a child to pronounce the letters of the alphabet, before the vocal organs are so developed that distinct utterance can be given to the proper sounds.

No part of the vocal organs is wanting, with those individuals that stammer, or who have an impediment in their speech. Some parts may be more developed than others. Generally, however, some parts are but imperfectly under the control of the will. Surgical operations and medical treatment are not highly advantageous in a majority of these cases. In the young and middle aged, this defect can be removed by *patient* and judicious training. Let such sounds be made and such words be uttered as can be made and uttered with distinctness. Let there be repetition, until the words can be spoken at any time with readiness. Then take for a lesson other words and sounds more difficult, and pursue a similar process of training and repetition, until the vocal organs can be called into ready and harmonious action in giving utterance to any word in common use.

When should a child be taught the alphabet? Why? How is stammering to be corrected?

CHAPTER IX.

THE CIRCULATORY SYSTEM.

THE fluid of the system, termed *blood*, is carried to and from the different parts of the system, by the agency of the *heart*, *arteries*, *veins*, and *capillaries*. Each of these make a part of the circulatory system.

ANATOMY OF THE HEART.

The HEART is placed obliquely in the left cavity of the chest, the base being directed upwards and backwards, towards the right shoulder, while its apex points forward, to the left, about three inches from the sternum, to the space between the fifth and sixth ribs. Its under side rests upon the tendinous portion of the diaphragm.

The heart is surrounded by a sac, called the *pericardium*, or heart case. The interior surface of this membrane secretes a serous fluid, that lubricates the exterior of the heart, and obviates friction between it and the pericardium. In health, there is usually about a tea-spoonful of this fluid. It sometimes, in disease, amounts to several ounces, which is named dropsy of the heart.

The heart usually weighs from eight to ten ounces. It is composed of muscular fibres, that traverse it in different directions, some longitudinally, but most of them in a spiral direction.

The human heart, like that of the sheep and of the ox, is a double organ; or, it is divided into two parts or sides

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Through what agency is the circulation of the blood effected? What is the position of the *heart* in the chest? In what direction is its base? Its apex? Upon what does its under side rest? What is the sac called which surrounds it? What is its use? What amount of fluid does this sac contain in health? When there is too great an accumulation of fluid, what is the disease called? What is the usual weight of the heart? Of what is it composed? In what direction do the fibres run? Is there a similarity between the heart of man and that of the lower animals?

—the right and the left. The compartments of the two sides are separated by a septum, or partition.

Fig. 122.

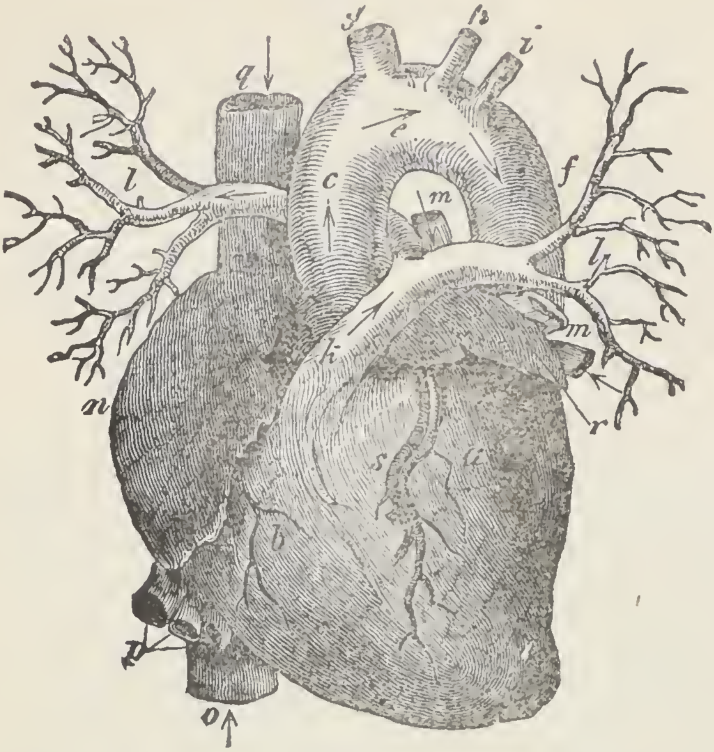

Fig. 122 gives a good idea of the general form of the heart, divested of the pericardium. The large blood vessels are seen opening into it at its upper part, which is the base; q, *descending vena cava;* o, ascending *vena cava;* n. *right auricle:* b, right *ventricle;* k, *pulmonary artery;* l. l, *right* and *left* branches of this artery, going to the lungs on either side of the chest; m, m, *veins* of the *lungs;* r, the *left auricle;* a, the *left ventricle;* c, e, f, *aorta,* or great artery of the body, rising out of the left heart; g, *arteria innominata:* h, the *subclavian artery:* i, the *carotid artery.*

Note. The arrows show the course of the blood in each of the vessels demonstrated with the heart; s, left coronary artery; p, veins returning the blood from the liver and bowels.

There is no essential difference in the external appearance or internal organization of the heart of man and that of breathing animals generally; hence, in a cabinet, it would be exceedingly difficult for a practical anatomist to designate the human heart from that of a brute, provided they were of equal dimensions.

Nothing is easier than to fill a heart with wax, or even plaster of Paris, in order to exhibit distinctly all its vessels, and its exact shape in a state of distension. The heart of any of the domestic animals, procured at the market, may be thus filled, and kept for many years.

The right side of the heart is divided into two parts, named the auricle and the ventricle. The auricle is called, by the butchers, the *deaf ear.* Its walls are thinner, and, in color, paler than those of the ventri-

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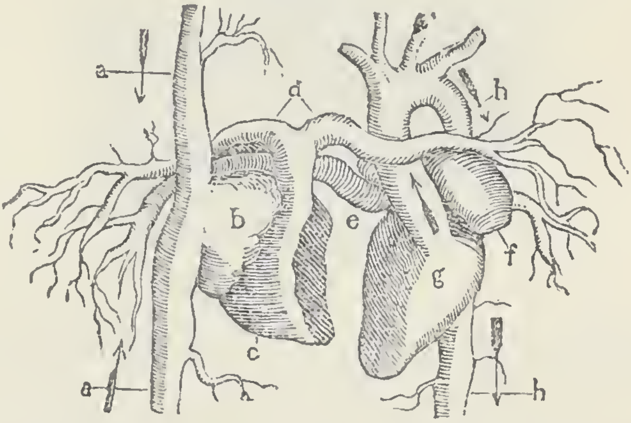
Describe Fig. 122. How is the right side of the heart divided? What is the auricle called by butchers? How does the auricle differ from the ventricle? What have the ventricles upon their internal surface?

cles have, upon their internal surface, pillars of flesh, named *columnæ carnea.* These columns can be seen upon the interior of the hearts of domestic animals. The walls of the left ventricle are much thicker than those of the right, in the heart of man, and the same is true of domestic animals. This is illustrated by comparing the thickness of the walls of the left side, represented at *i*, in fig. 126, with *l*, in fig. 124.

Fig. 123.



'By this engraving, the reader will readily understand what we mean by the *two hearts* of man and other warm-blooded animals, as they are here exhibited, and as they appear when dissected apart. Each one of them is a perfect organ by itself, and the one is perfectly independent of the other. That having the letter *b* upon it is the *right* heart, and that with *g*, the left. This is a front view, or as they would appear on looking into the chest of another person. The right heart is the engine of the *lungs*, for it supplies those organs exclusively. The left heart throws the blood round the curve above g, in the direction indicated by the arrows, over the entire body.

'*a*, *a*, Are the *cavas*, or great veins, returning blood from the head and arms, and lower extremities. The uppermost is the *superior vena cava*, and the one below, the *inferior vena cava.* The arrows show the direction of the returning currents of venous blood, to *b*, the *auricle*, which forces it into *c*, the ventricle, which again forces it up into *d*, the pulmonary artery, where it divides to go to each lung; *e*, is one of the *four pulmonary veins*, which convey the blood, just forced into the lungs, into the *auricle*, *f*, of the left heart. When that contracts, it drives its blood into g, the *ventricle*, which in its turn, forces it onward again into the arch of the *aorta*, the main pipe, where it glides along in the direction of the arrow, dividing into smaller streams on its way, and finally goes down the *descending aorta*, *h*, to supply the body below.

'There are many animals which have only the right heart, but none that possess the *left one* alone. The fish's heart is single, equivalent to the right heart of man.'

Between the auricle and ventricle, on the right side, there are three folds of thin triangular membrane, named the tricuspid valves. There are seen passing from the floating edge of these valves to the columnæ carnea small white cords, named the *cordæ tendinæ.*

Describe Fig. 123. Is the human heart a single organ? How divided? Are there any animals that have the *left* heart alone? The *right?* What is situated between the auricle and ventricle of the right side of the heart? What passes from these valves to the columnæ carnea?

Fig. 124.

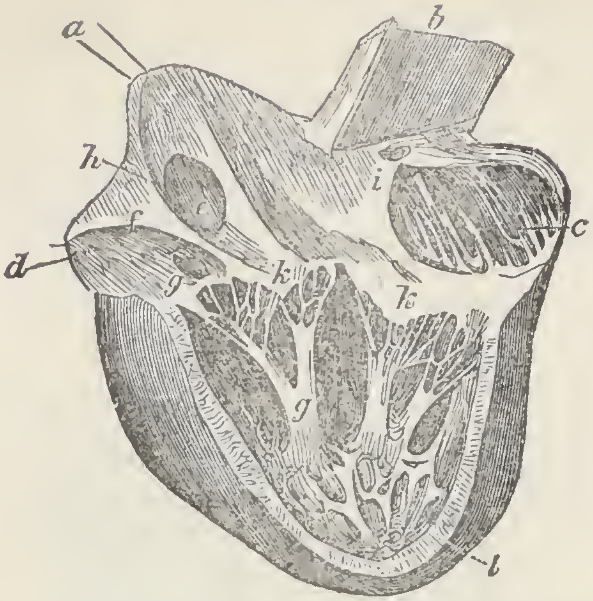


Fig. 124 represents the right auricle and ventricle laid open, bringing to view the tricuspid valves, columnæ carneæ, and cordæ tendinæ; *b*, superior vena cava; *a*, *d*, orifice of the inferior vena cava; *l*, thin walls of the ventricle; *k*, *k*, the tricuspid valves; *g*, one of the columnæ carneæ, from which is seen passing to *k*, white lines, which represent the cordæ tendinæ; *i*, the auricle laid open; *e*, foramen ovale.

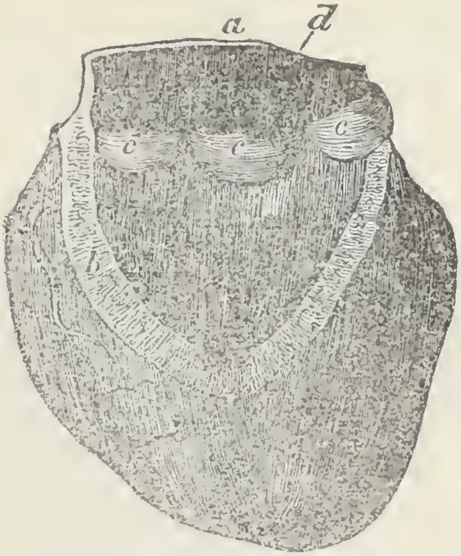
From the right ventricle, the venous blood passes through the pulmonary artery, to the lungs. At the commencement of this artery, there is placed three valves, named the sigmoid, or semilunar valves of the pulmonary arteries.

Between the auricle and ventricle of the left side of the heart, there are two valves, named mitral. To the free margins of these valves are attached small tendinous cords, that connect them with the fleshy pillars upon the interior of the ventricle.

From the left ventricle, proceeds the large systemic artery, named the aorta, through which the *arterial* blood passes to the whole system. At the junction of this artery with the ventricle, there are three valves, named sigmoid, or semilunar valves of the aorta. They receive their name from their form.

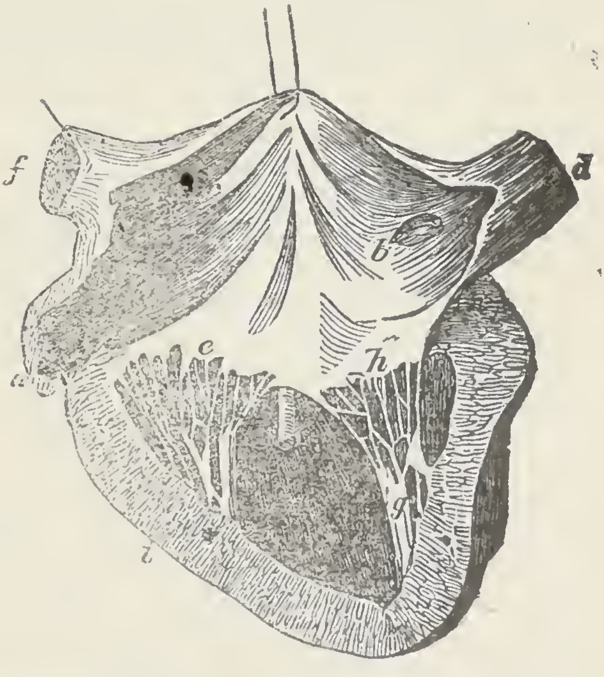
Describe the course of the blood from the right ventricle. What are found at the commencement of the pulmonary artery? What are the names of the valves between the auricle and ventricle of the left side of the heart? What are attached to these valves? What vessel passes from the left ventricle of the heart? How many valves at the junction of this artery with the ventricle?

Fig. 125.



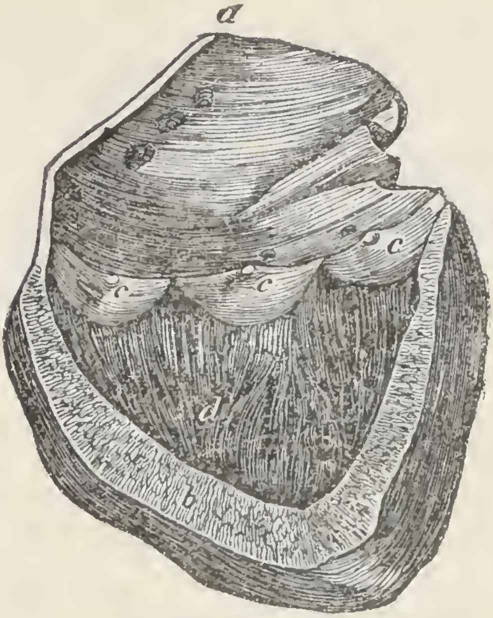
This figure represents the pulmonary artery and right ventricle laid open, bringing to view the semilunar valves of the artery. *a*, Pulmonary artery; *b*, Walls of ventricle; *c*, *c*, *c*, Semilunar valves at the commencement of the artery.

Fig. 126.



This figure represents the left auricle and ventricle laid open. *a*, *f*, *d*, Represent the veins through which the blood is returned from the lungs; *i*, walls of left ventricle; *e*, *h*, mitral valves between the left auricle and ventricle; *g*, one of the fleshy pillars, called columnæ carneæ, from which white lines pass to the valve, *h*. Those are the cordæ tendineæ.

Fig. 127.



a, Aorta laid open; *d*, left ventricle laid open; *b*, walls of ventricle; *c*, *c*, *c*, semilunar valves.

The heart is supplied with arteries and veins, which ramify between its muscular fibres, through which its *nutrient* blood passes. It has, likewise, a few absorbents, and many small nervous filaments from the ganglionic system of nerves.

ANATOMY OF THE ARTERIES.

The ARTERIES are the cylindrical tubes, which convey the blood from the heart to every part of the system. They are dense in structure, and preserve, for the most part, the cylindrical form when emptied of their blood, which is their condition after death. They were considered by the ancients as the vessels for the transmission of vital spirits, and were therefore named *arteries*, signifying *to contain air.*

Arteries are composed of three coats. The external or cellular coat is firm and strong; the middle, or fibrous coat, is composed of yellowish fibres. This coat is elastic, fragile, and thicker than the external coat. Its elas-

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What does Fig. 127 exhibit? How is the heart nourished? Is it also supplied with absorbents and nervous filaments? Describe the *arteries*. What function did the ancients suppose them to perform? How many coats have they? Describe each.

ticity enables the vessel to accommodate itself to the quantity of blood it may contain. The internal coat is a thin serous membrane, which lines the interior of the artery, and gives it the smooth polish which that surface presents. It is continuous with the lining membrane of the heart.

The arteries do not terminate directly in veins, but in an intermediate system of vessels, which, from their minute size, are called capillaries. Communications between arteries are free and numerous. They increase in frequency with diminution in the size of the branches, so that through the medium of the minute ramifications, the entire body may be considered as one circle of inosculation, or anastomoses.

The arteries, in their distribution through the body, are enclosed in a loose, cellular investment, called a sheath, which separates them from the surrounding tissues. The sheath of the arteries contains also their accompanying veins, and sometimes nerves. The coats of the arteries are supplied with blood, like other organs of the body, and the vessels which are distributed to them are named *vasa vasorum.* They are also provided with ganglionic nerves.

THE PULMONARY ARTERY.

The PULMONARY ARTERY has its origin at the base of the right ventricle, in front of the origin of the aorta. It ascends obliquely to the under surface of the arch of the aorta, where it divides into two branches, one of which passes to the right; the other to the left lung. These divide and subdivide in the structure of the lungs, and terminate in capillary vessels, which form a net-work around the bronchial cells, and become continuous with the radicles of the pulmonary veins. This artery conveys the impure blood to the lungs, and, with its corresponding veins, establishes the *lesser or pulmonic circulation.*

Do the arteries terminate directly in veins? What may the entire body of these minute ramifications be considered? How are the arteries separated from the surrounding tissues? What does the sheath contain? What is the name of those vessels which supply the coats of the arteries with blood? Have these coats nerves? Describe the *pulmonary artery.* What is said of its divisions and subdivisions? What establishes the lesser or pulmonary circulation?

Fig. 128.

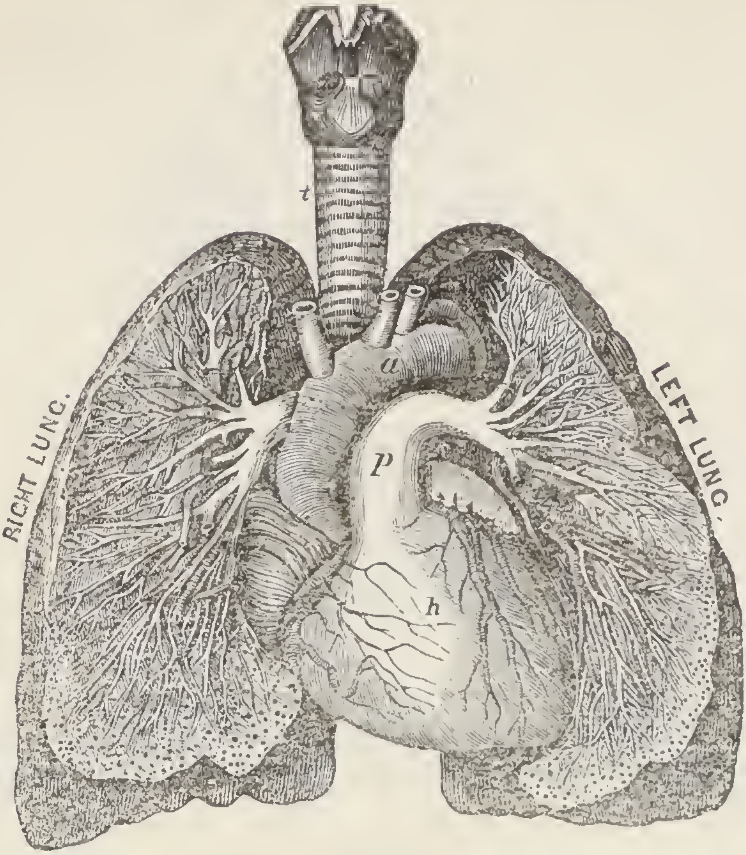

Fig. 128. *t*, is the trachea; *h*, the heart; *a*, the aorta; *p*, pulmonary artery, which divides under the arch of the aorta into two branches. These branches divide and subdivide into smaller vessels, which spread through every part of the right and left lung; and they terminate in the capillary vessels of the lungs. The capillary vessels ramify upon the air-cells represented by the small dark points around the margin of the lungs.

THE AORTA AND ITS BRANCHES.

The AORTA proceeds from the left ventricle of the heart, and contains the pure or arterial blood. This trunk gives off branches, which divide and subdivide to their ultimate ramifications, constituting the great arterial tree which pervades, by its minute subdivisions, every part of the animal frame. This great artery and its divisions, with their returning veins, constitute the *greater or systemic circulation.* The aorta ascends, at first, to the right, then curves backwards to the left, and descends on the left side of the vertebral column behind the heart. It is

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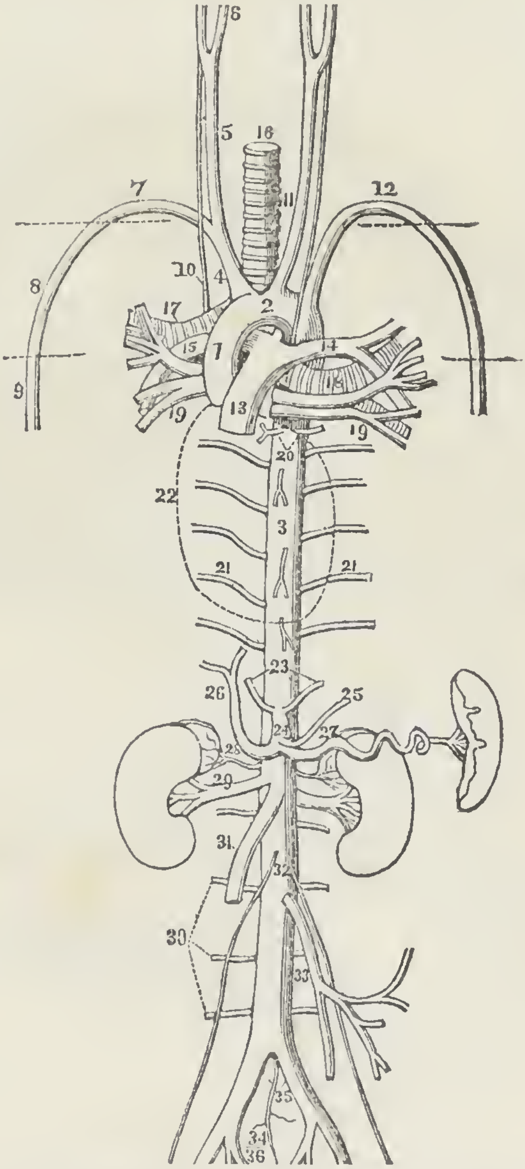
What is the design of Fig. 128. Describe the *aorta.* What constitutes the greater or systemic circulation? Describe the course of the aorta.

divided into the ascending and descending aorta. In the thorax it is called the thoracic aorta ; in the abdomen, the abdominal aorta.

Fig. 129.



16, The trachea ; 17, 18, the right and left branch ; 1, the ascending aorta ; 2, the arch of the aorta ; 3, descending aorta ; 4, the arteria innominata, dividing into two branches ; 5, the right carotid artery ; 6, the right internal carotid artery ; 7, the right subclavian artery ; 8, 9, the brachial artery ; 10, pneumogastric nerve ; 11, left carotid artery ; 12, left subclavian artery ; 13, the pulmonary artery ; 14, 15, the right and left pulmonary artery ; 19, 19, the pulmonary veins ; 20, 21, 22, the intercostal arteries ; 23, the diaphragmatic arteries ; 24, the cœliac artery ; 25, the gastric arte-

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What name is given to it in the thorax ? In the abdomen ?

ry; 26, the hepatic artery; 27, the splenic artery; 28, the renal artery; 30, the lumbar arteries; 31, the superior mesenteric artery; 32, the spermatic arteries; 33, the inferior mesenteric artery; 35, the division of the aorta into the common iliac artery; 36, the iliac artery.

The arteries 5, 6, and 11, supply the neck and head with blood; 7, 8, 9, and 12, the superior extremities; 13, 14, and 15, the lungs; 20, 21, and 22, the ribs and muscles of the chest; 23, the diaphragm; 25, the stomach: 26, the liver; 27, the spleen; 28, the kidneys; 31 and 33, the intestines; 36, the pelvic organs.

Fig. 130.

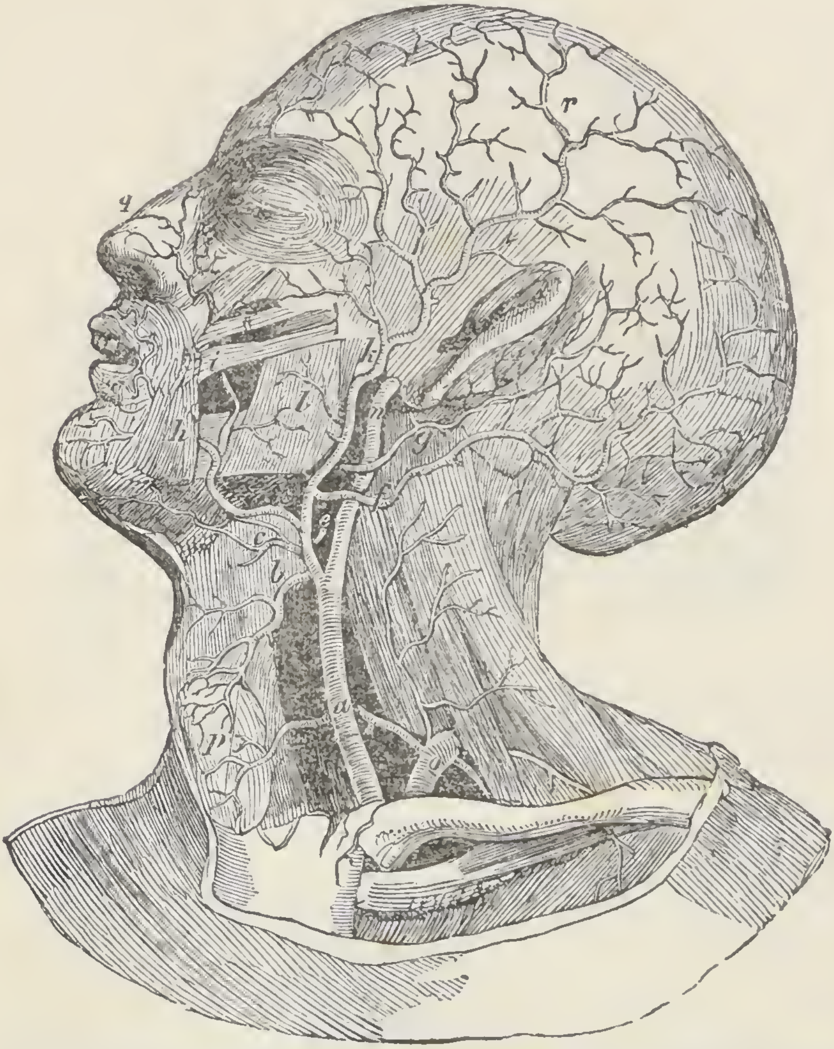


Fig. 130 represents the common and external carotid arteries, with their principal superficial branches; *a*, the common carotid artery; *b*, the superior thyroid artery; *p*, the thyroid gland and inferior thyroid artery; *n*, the external carotid; *f*, the occipital artery; *h*, *l*, and *i*, muscles of the face; *c*, the facial artery; *k*, the temporal artery; *r*, its terminal branches; *q*, the nasal artery; *o*, the subclavian artery that passes over the first rib and under the clavicle to the arm. The carotid artery is the vessel usually divided in suicides. Compression of this vessel, and its fellow on the opposite side of the neck, will induce apoplexy and death.

What vessel is usually divided in suicides? What effect has compression on this vessel?

Fig. 131.

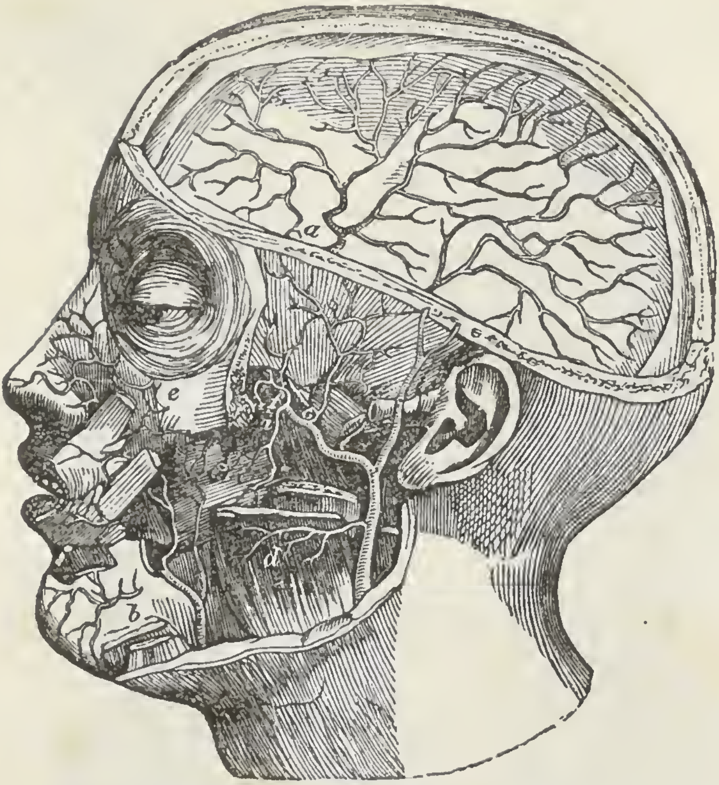


Fig. 131. *a*, is the *middle* or great *meningeal artery of the dura mater*. By the side of the ear, lies the trunk of the *internal maxillary* artery, supplying a vast quantity of blood to the muscles of the face; part of the jaw and the process of the temporal bone is removed, to explain the manner of its course under and about them. *b*, A branch of the *inferior maxillary artery*, seen in the other plan; *c*, *posterior temporal branch; d*, *pterygoid arteries*, supplying those muscles which move the jaw in chewing; *i*, *buccal artery*, going to the buccinator, or trumpeter's muscle; *f*, *anterior deep temporal* branch; *e*, *infra orbitar artery*.

The bone in this figure is supposed to have been taken away in order to exhibit the artery, *a*, which, like the limbs of a tree, branches over the surface of the dura mater.

The brain is mainly supplied with blood, by the two internal carotids, that proceed from the common carotids, and the two vertebral arteries that proceed from the subclavian arteries. The passage of the carotids through the thick bones at the base of the skull is tortuous, like the letter *S*. The vertebral arteries ascend the neck in channels formed in the transverse processes of the cervical vertebræ, and enter the cavity of the skull at its posterior part, by the side of the spinal cord. The two carotids and two vertebral arteries communicate with each other and ramify through and supply blood to the brain.

What vessels supply the brain with blood?

Fig. 132.

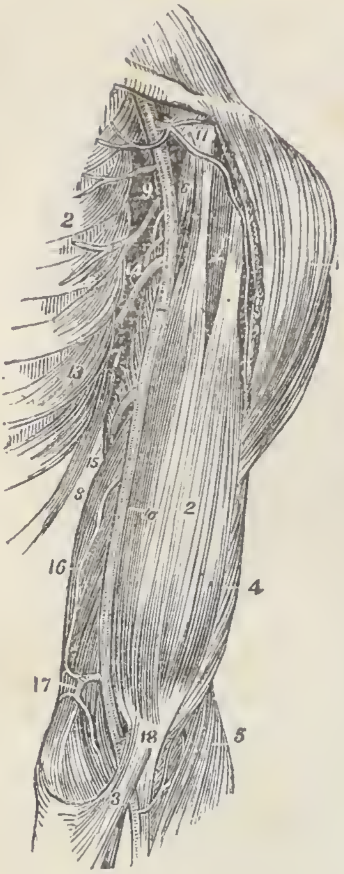


Fig. 133.

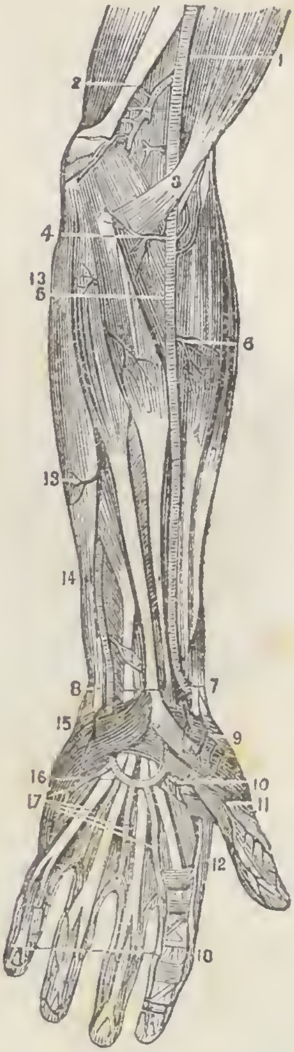


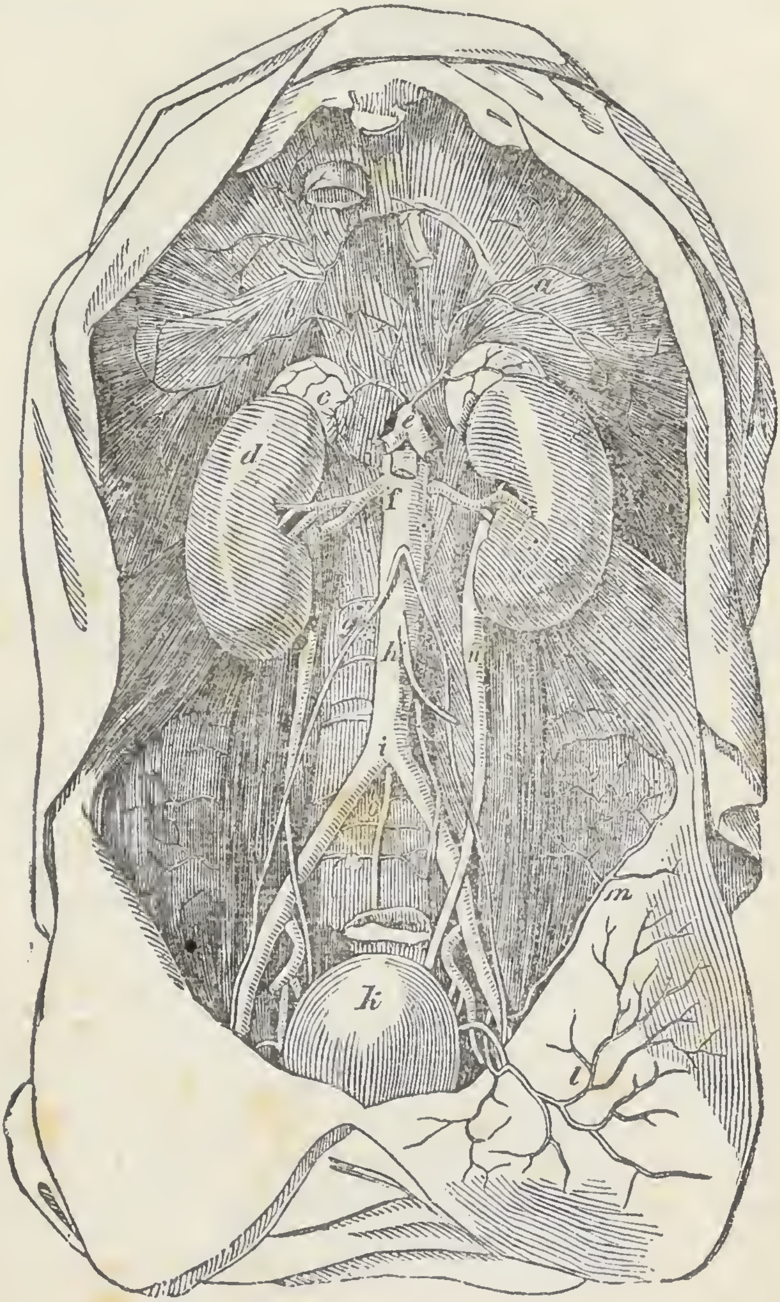
Fig. 132 is a representation of the axillary and brachial arteries with their branches. 1, The deltoid muscle; 2, the biceps; 3, the tendinous process from the tendon of the biceps; 4, the brachialis internus muscle; 5, the supinator longus; 6, the coraco brachialis; 7, the middle portion of the triceps muscle; 8, its inner head; 9, the axillary artery; 10, the brachial artery; 11, the acromial artery; 12, the thoracic arteries; 13, the serratus magnus muscle; 14, the subscapular artery; 15, the profunda major artery; 16, the profunda minor artery; 17, the anastomosing artery; 18, the profunda major inosculating with the radial recurrent artery.

The arteries 11, 12, 14, 15, 16, 17, and 18, supply the bones, muscles, and skin of the arm, with blood.

Fig. 133 is a view of the arteries of the lower portion of the superior extremity. 1, The lower part of the brachial artery; 2, the anastomosing arteries; 3, aponeurotic expansion of the biceps; 4, the recurrent radial artery; 5, the radial artery; 6, muscular branches; 7, the superficial volar artery; 8, the tendons passing under the annular ligament; 9, a branch of the volar artery on the ball of the thumb; 10, the palmaris profunda artery; 11, the artery of the thumb; 12, the artery of the forefinger; 13, the muscular arteries of the arm; 14, the lower part of the ulnar artery; 15, branches to the palm and muscles of the little finger; 16, the superficial arch of the radial and ulnar arteries; 17, branches running to supply the fingers; 18, the digital arteries that supply the fingers with blood.

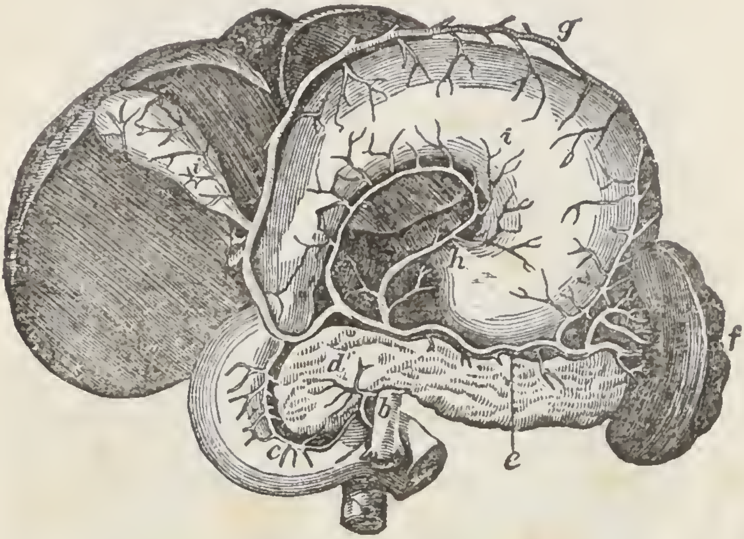
Figs. 134, 135, and 136 represent the branches and division of the abdominal aorta, and the ramification of arteries to the liver, stomach, pancreas, spleen, kidneys, and intestines.

Fig. 131.



‘ In this diagram, *a* and *b* show the tendinous part of the diaphragm, or partition between the chest and abdomen ; *d*, the kidney, with its fellow opposite ; *f*, the *descending aorta ;* *h*, an artery given off for the intestinal tube ; *i*, where the great artery divides, to send a branch to each leg ; *g*, the ascending great vein, conveying blood to the right side of the heart: c, the *capsule*, so called, belonging to the kidney, the use of which is unknown; n, the *ureter*, a tube which conveys the urine from the kidney to the under side of the bladder, where it terminates. The right ureter is seen on that side, also terminating in the bladder, k: m, l, are arteries; o, is a small artery, which runs down the lumbar vertebræ into the pelvis.

Fig. 135.



b, The superior mesenteric artery; d, the pancreas; f, the spleen; g, superior coronary artery of the stomach; h, inferior coronary artery; these, with a branch from the spleenic artery, e, supply the stomach with blood: c, a branch of the coronary artery that supplies the duodenum with blood; e, the cystic artery, that ramifies upon the gall cyst, seen on the under surface of the liver.

From this engraving it will be seen that the stomach, which is one of the most important organs in the animal economy, is supplied with sanguineous fluid, not only from its own coronary arteries, but from the arteries that pass to it from the liver and spleen. A peculiarity of these arteries, is that, though arising from three sources, they inosculate with each other.

In fig. 136, the arteries that pass to the different parts of the intestines, present also the anastomosing arrangement. The same arrangement is strikingly true of the cerebral arteries, that supply the brain with nutrient blood. The nutrition of the system, the continuance of the digestive functions, the varied offices of the muscles, and the functions of the cerebral organ, depend on a continuous flow and also a full supply of the circulating fluid. Let an artery become obliterated, by pressure or disease, — a circumstance by no means infrequent, — and the or-

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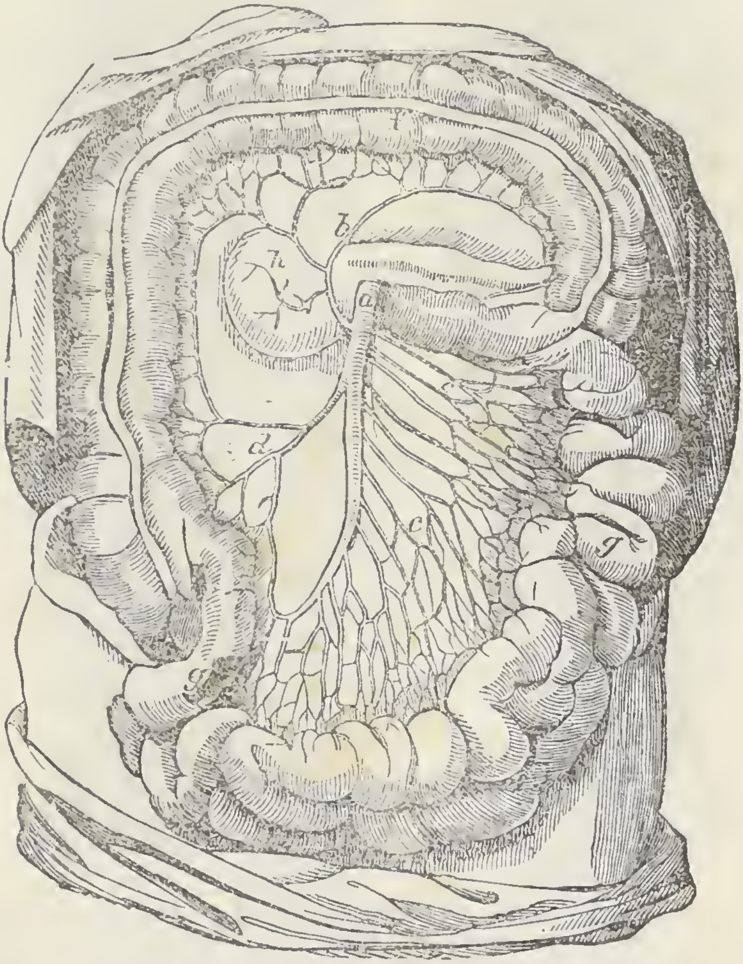
Show the design of Fig. 135.

gans are yet duly supplied with blood from the inosculating arrangement of the arteries. When a trunk is ligated or rendered impervious to blood, the minute anastomosing arteries, that perform a vicarious office, become enlarged, and consequently, the nutrition of the organ is not impaired.

Fig. 136



In the above engraving, the ascending colon, commencing on the right side, with the transverse colon *f*, is represented with the pouches; *g*, *g*, represent a portion of the small intestine; *a*, *b*, *c*, *d*, *h*, represent the superior mesenteric artery and branches, through which the blood that nourishes the large and small intestines passes. The anastomoses, or the connection of arteries, is beautifully represented, and is worth the attention and remembrance of the student. The inosculation, or hoop-like connection of the arteries here exhibited, exists in every part of the system.

The four following engravings illustrate the course of the principal artery and its branches in the lower limbs.

What is the object of fig. 136? What do the four following figures show?

Fig. 137.

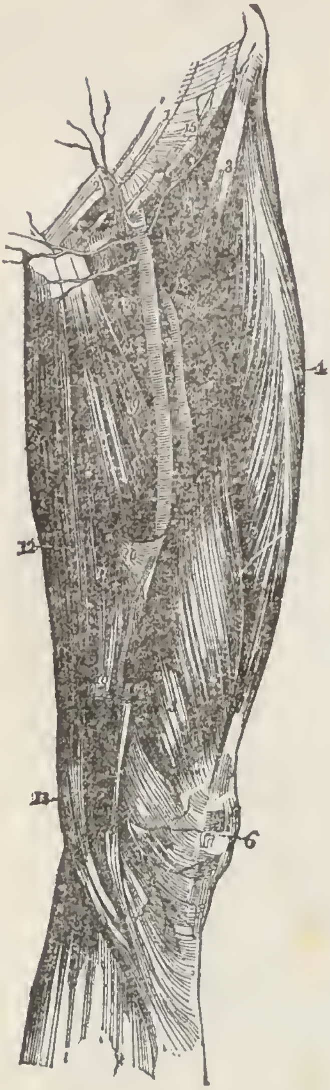


Fig. 138.

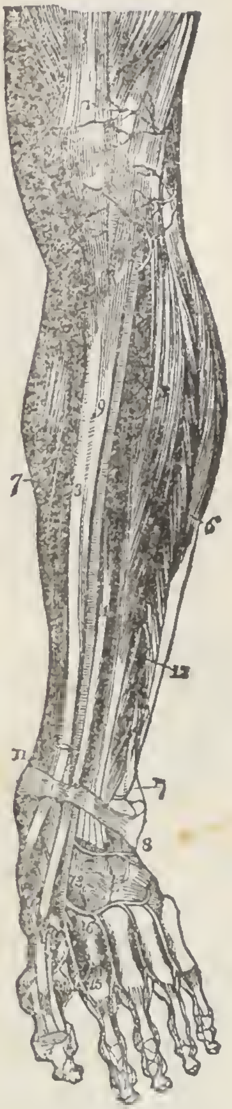


Fig. 137. A view of the superficial and inner aspect of the thigh, showing the course and branches of the femoral artery. 1, The lower part of the aponeurosis of the external oblique muscle; 2, the external abdominal ring; 3, 3, the upper and lower part of the sartorius muscle; 4, the rectus; 5, the vastus internus; 6, the patella; 7, the iliacus and psoas; 8, the pectineus; 9, the adductor longus; 10, the tendinous canal for the femoral artery; 11, the adductor magnus; 12, the gracillis; 13, the tendon of the semitendinosus; 14, the femoral artery; 15, the superficial circumflexa ilii artery; 2, the superficial epigastric artery; 16, the two external pudic arteries, superficial and deep; 17, the profunda artery, giving off (18) its external circumflex branches; and lower down the three perforantes. A small bend of the internal circumflex artery (8) is seen behind the inner margin of the femoral, just below the deep external pudic artery; 19, the anastomotica magna, descending to the knee, upon which it ramifies (6).

Fig. 138. The anterior aspect of the leg and foot, showing the anterior tibial and dorsalis pedis arteries, with their branches. 1. The tendon of insertion of the quadriceps extensor muscle; 2, the insertion of the ligamentum patellæ; 3, the tibia; 4, the extensor proprius pollicis muscle; 5, the extensor longus digitorum; 6, the peronei muscles; 7, the inner belly of the gastrocnemius and the soleus; 8, the annular ligament, beneath which the extensor tendons and the anterior tibial

artery pass into the dorsum of the foot; 9, the anterior tibial artery; 10, its recurrent branch inosculating with (2) the inferior articular, and (1) the superior articular artery, branches of the popliteal; 11, the internal malleolar artery; 17, the external malleolar, inosculating with the anterior peroneal artery, 12; 13, the dorsalis pedis artery; 14, the tarsea and metatarsea arteries; the tarsea is nearest the ankle, the metatarsea is seen giving off the interosseæ; 15, the dorsalis hallucis artery; 16, the communicating branch.

Fig. 139.

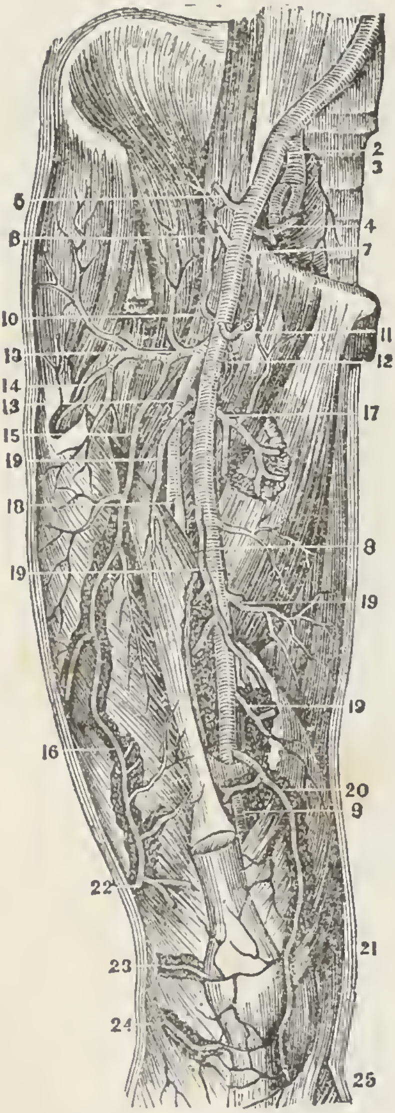


Fig. 140.

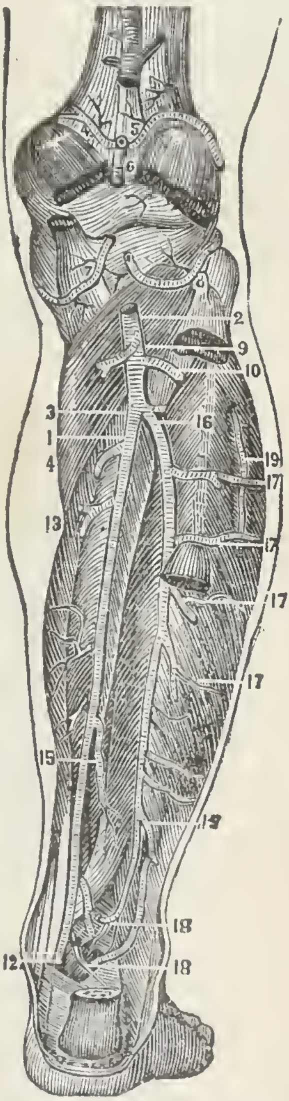
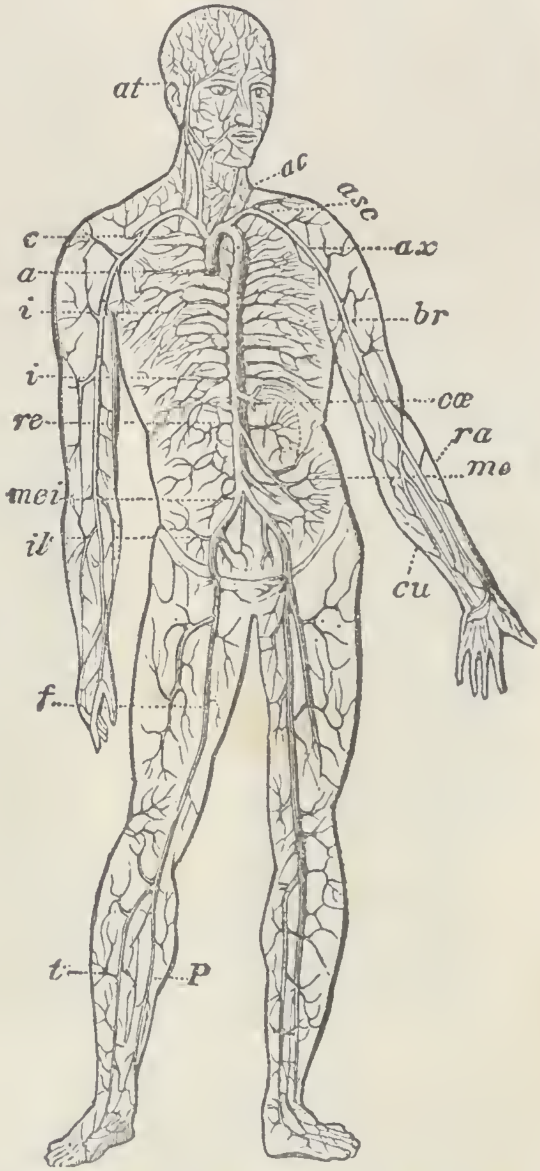


Fig. 139. A front view of the iliac and femoral artery; 2, the internal iliac; 3, the external iliac; 4, the epigastric; 5, the circumflex ilii; 6, the cuticular abdominal; 7, the commencement of the femoral, below the crural arch; 8, the point where it passes the vastus internus muscle; 9, the point where it leaves the front of the thigh, to become popliteal; 10, the muscular branch to the psoas muscle: 11, the external pudic artery; 12, the internal circumflex; 13, the profunda femoris; 14, muscular branch; 15, 16, artery to the vastus externus muscle; 17, artery to the pectineus and adductors; 18, the first perforating artery; 19, 19, muscular arteries; 20, 21, anastomotica; 22, the superior articular; 23, the middle articular; 24, the inferior external articular; 25, the inferior internal articular.

Fig. 140. A view of the arteries on the back of the leg; 2, the lower end of the

popliteal artery on the popliteus muscle; 3, the point of bifurcation into the posterior tibial and peroneal; 4, the superior internal articular artery; 5, the superior external articular artery; 6, the middle articular artery; 7, the inferior internal articular artery; 8, the inferior external articular artery; 9, branch of the head of the soleus muscle; 10, the origin of the anterior tibial artery; 1, the origin of posterior tibial artery; 12, the point where it passes behind the annular ligament to become the plantar; 13, 14, 15, muscular branches; 16, the origin of the peroneal artery; 17, 17, muscular branches; 18, 18, anastomosis of the posterior tibial and peroneal arteries near the heel; 19, muscular branch from the anterior tibial.

Fig. 141.

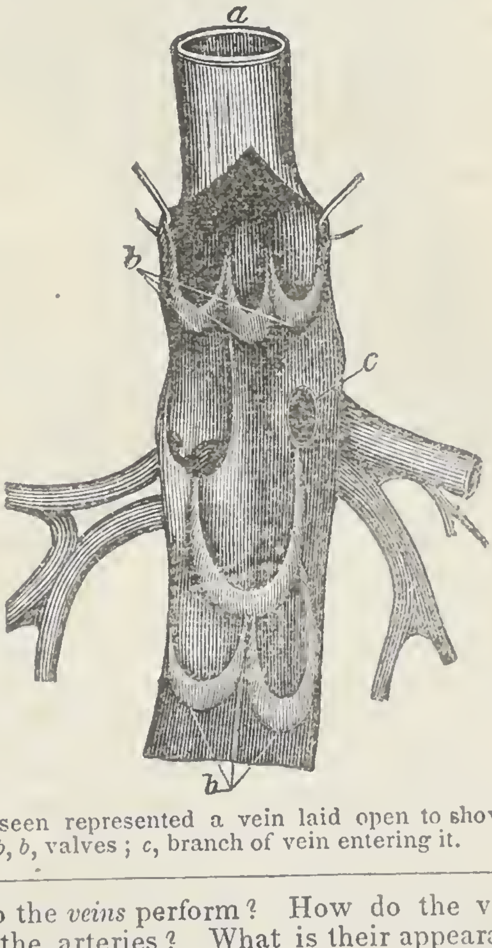


' Fig. 141 represents the aorta and its branches. *a*, The aorta; *c*, arch of the aorta; *ac*, carotid arteries; *at*, temporal arteries; *asc*, subclavian artery; *ax*, axillary artery; *br*, brachial artery; *ra*, radial artery; *cu*, cubital or ulnar artery; *i*, *i*, intercostal arteries; *cœ*, cœliac artery; *re*, renal arteries; *me*, and *mei*, superior and inferior mesenteric arteries; *il*, iliac arteries; *f*, femoral arteries; *t*, tibial artery; *p*, the peroneal artery.

ANATOMY OF THE VEINS.

The VEINS are the vessels which return the blood to the auricles of the heart, after it has been circulated, by the arteries, through the various tissues of the body. They are thinner in structure than the arteries, so that, when emptied of their blood, they become flattened and collapsed. The veins of the systemic circulation convey the dark-colored and impure, or venous blood, from the capillary system to the right auricle of the heart. They are found, after death, more or less distended with that fluid. The veins of the pulmonic circulation resemble the arteries of the systemic circulation, in containing, during life, the pure or arterial blood, which they transmit from the capillaries of the lungs to the left auricle.

Fig. 142.



In this figure is seen represented a vein laid open to show the valves; trunk of the vein ; *b*, *b*, valves ; *c*, branch of vein entering it.

What office do the *veins* perform? How do the veins compare in structure with the arteries? What is their appearance after death? How do the veins of the pulmonic circulation resemble the arteries of the systemic circulation?

The veins commence by minute radicles, in the capillaries, which are every where distributed through the textures of the body, and converge, to constitute larger and larger branches, till they terminate in the large trunks which convey the venous blood directly to the heart. In diameter they are much larger than the arteries, and, like those vessels, their combined area would constitute an imaginary cone, the apex of which is placed at the heart, and the base at the surface of the body. The communications between the veins are more frequent than those of the arteries, and take place between the larger as well as among the smaller vessels. The office of these inosculations is very apparent, as tending to obviate the obstructions to which the veins are peculiarly liable, from the thinness of their coats, and from inability to overcome great impediments by the force of their current.

Veins, like arteries, are supplied with nutrient vessels, the *vasa vasorum;* and it is to be presumed that nervous filaments from the ganglionic nerves are distributed to their coats.

Veins are composed of three coats; *external*, *middle*, and *internal.*

The external, or cellular coat, is dense and firm, resembling the cellular tunic of the arteries. The middle coat is fibrous, like that of the arteries, but extremely thin.

The internal coat is serous, and also similar to that of the arteries. It is continuous with the lining membrane of the heart at one extremity, and with the lining of the capillaries at the other. At certain intervals, the internal coat forms folds, or duplicates, which constitute valves. They are generally composed of two semi-lunar folds, one on each side of the vessel. The free extremity of the valvular folds is concave, and directed forwards, so that while the current of blood sets towards the heart, they present no impediment to its free passage; but let the current become retrograde, and it is impeded by their distension. The valves are most numerous in the veins of the extremities, particularly the deeper veins situated

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Where do the veins commence? How does their diameter compare with that of the arteries? What does their combined area constitute? Where is its apex? Its base? What is the apparent design of the inosculation of the veins? Have the veins nutrient vessels, like the arteries? How many coats have they? Describe each coat. How are the valves in the veins formed? What is their use? Where are they most numerous?

between the muscles. They are absent in the small veins, and also in the large trunks.

Fig. 143.

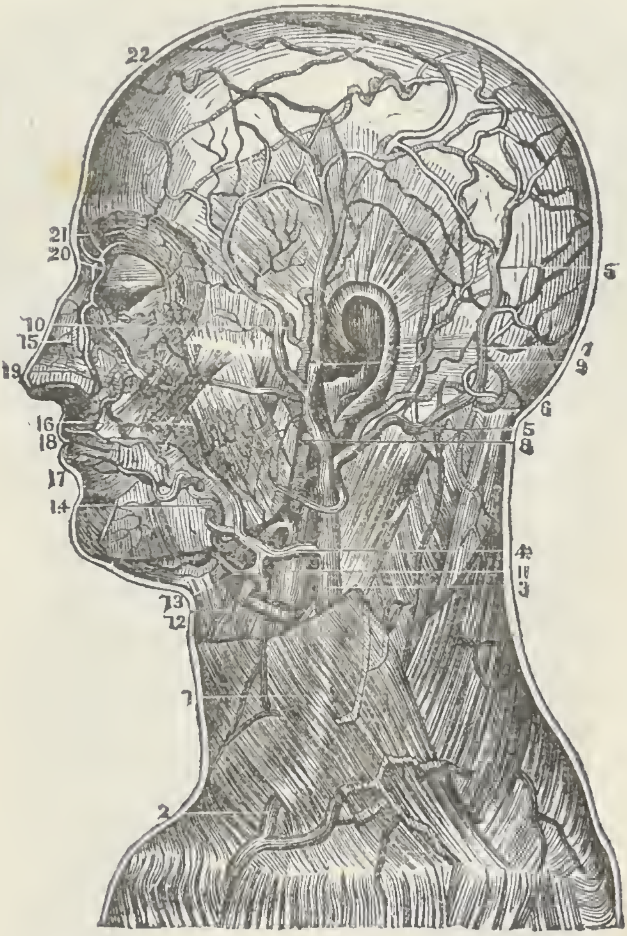

Fig. 143. A side view of the superficial arteries and veins of the face and neck. 1, the external jugular vein; 2, the anastomosing branch of the cephalic vein of the arm, to the external jugular; 3, the external jugular vein; 4, communications of the external and internal jugular vein; 5, the occipital vein and branches; 6, the occipital artery; 7, the posterior auricular artery and vein; 8, the point where the external jugular is formed by the union of the temporal and internal maxillary veins; 9, the temporal artery and vein; 10, the frontal branches of the same; 11, the internal jugular vein; 12, the superior thyroid artery and vein; 13, the lingual artery and vein; 14, the facial artery; 15, the point of union between the nasal and facial artery; 16, the facial vein separated from the artery, except at its origin and termination; 17, the inferior coronary artery and vein; 18, the superior coronary artery and vein; 19, the ascending nasal vein; 20, the nasal branches of the ophthalmic artery and vein; 21, 22, the frontal vein.

The veins of the exterior of the head, as the facial, internal maxillary, temporal, posterior auricular, and occipital, unite with the veins from the brain, and form the two internal and external jugular veins, that are seen repre-

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How are the internal and external jugular veins formed?

sented upon the neck. These veins unite with the large veins from the upper extremities.

Fig. 144.

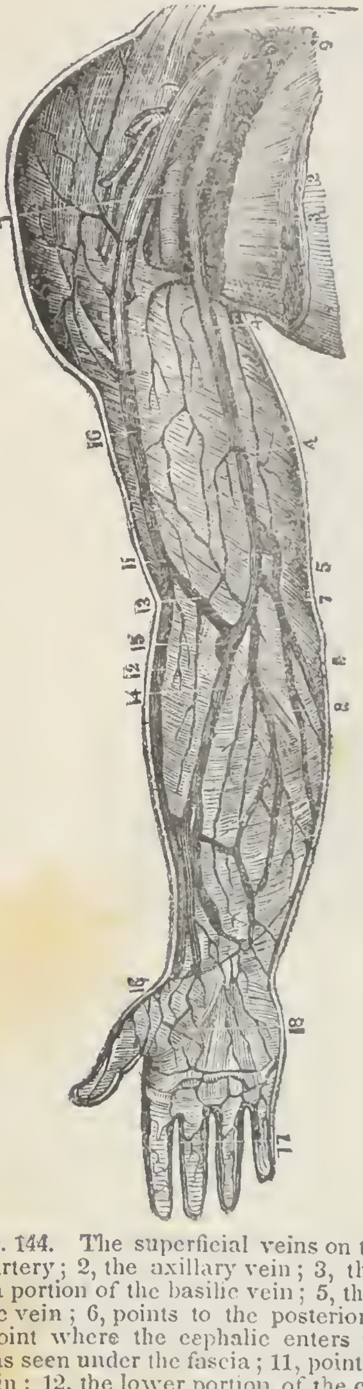


Fig. 145.

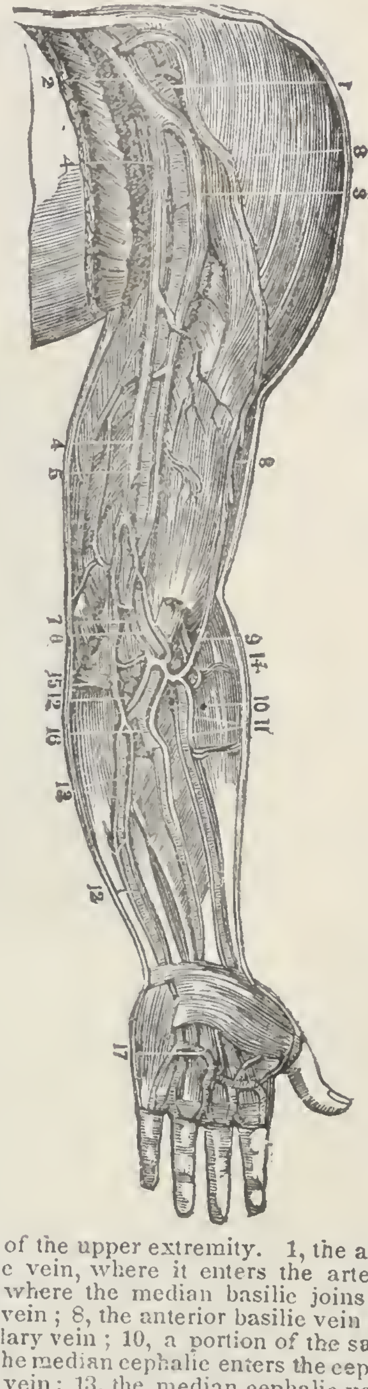


Fig. 144. The superficial veins on the front of the upper extremity. 1, the axillary artery; 2, the axillary vein; 3, the basilic vein, where it enters the artery; 4, 4, a portion of the basilic vein; 5, the point where the median basilic joins the basilic vein; 6, points to the posterior basilic vein; 8, the anterior basilic vein; 9, the point where the cephalic enters the axillary vein; 10, a portion of the same vein as seen under the fascia; 11, point where the median cephalic enters the cephalic vein; 12, the lower portion of the cephalic vein; 13, the median cephalic vein; 14, the median vein; 15, anastomosing branch of the deep and superficial veins of the arm; 16, the cephalica-pollicis vein; 17, the subcutaneous veins of the fingers; 18, the subcutaneous palmar veins.

Fig. 145. The deep-seated veins on the front of the upper extremity, in their relation to the arteries. 1, the axillary artery; 2, the axillary vein; 3, the humeral

vein; 4, the basilic vein; 5, the brachial artery; 6, the same artery at the bend of the arm; 7, the median basilic vein; 8, 8, the cephalic vein; 9, the median cephalic vein; 10, the radial artery; 11, its two attending veins; 12, 12, the ulnar artery; 13, its two attending veins; 14, the recurrent radial artery and vein; 15, the recurrent ulnar artery and vein; 16, the interosseal arteries and veins; 17, the palmar arch and vessels of the fingers.

The upper extremities have both the deep-seated and superficial veins. The deep-seated veins accompany the branches and trunks of the arteries, and constitute their venæ comites. The superficial veins upon the fore arm are named the anterior and posterior radial and ulnar. These unite at the elbow to form the median basilic and cephalic veins. These veins unite and form in the arm the cephalic and basilic veins. These, with the deep seated-veins, coalesce, and form the axillary and subclavian veins. The right and left subclavian, with the jugular veins of the right and left side, form the vena cava descending.

The veins of the lower extremities are deep-seated and superficial. The deep-seated veins accompany the arteries in pairs, and form the venæ comites of the anterior and posterior tibial and peroneal arteries. These veins unite at the bend of the knee, termed the popliteal region, and form a single vein of large size, named the popliteal. This vein becomes the femoral in the thigh, and the iliac at the lower part of the abdomen. It receives the external and internal saphena veins. The latter is frequently seen dilated on the inner side of the limb forming the varicose veins. The two iliac veins unite to form the vena cava ascending.

The veins of the trunk may be divided as follows, viz: 1, The superior vena cava, with its formative branches. 2, The inferior vena cava, with its formative branches. 3, The azygos vein. 4, The vertebral and spinal veins. 5, The cardiac veins. 6, The portal veins. 7, The pulmonary veins. The vertebral and spinal veins convey the blood from the spinal cord and vertebral column. The cardiac veins receive the blood from the heart. The portal veins receive the blood from the spleen and intestines, and convey it to the liver; while the pulmonary veins transfer the blood from the lungs to the left side of the heart.

How are the subclavian veins formed? How is the popliteal vein formed? How are the veins of the trunk divided?

Fig. 146.

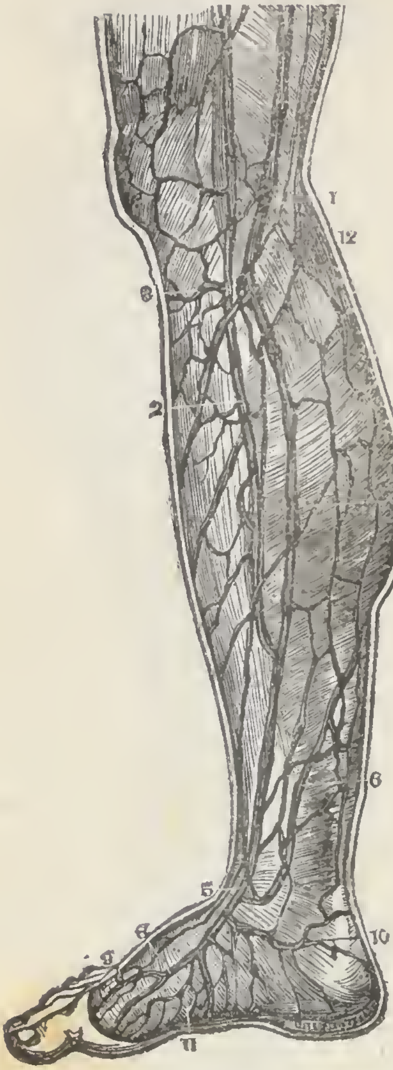


Fig. 147.

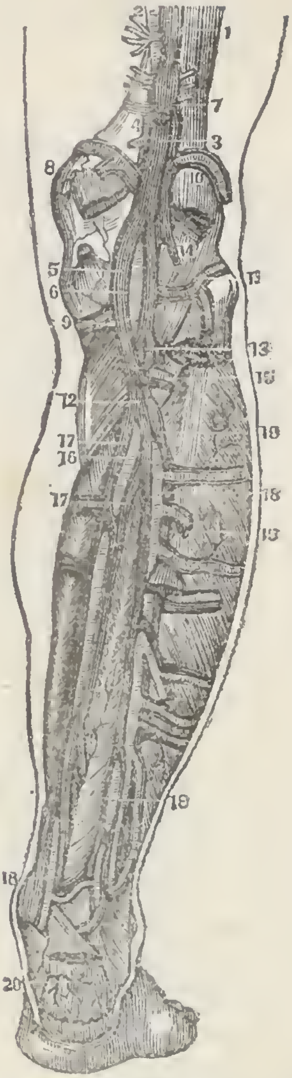
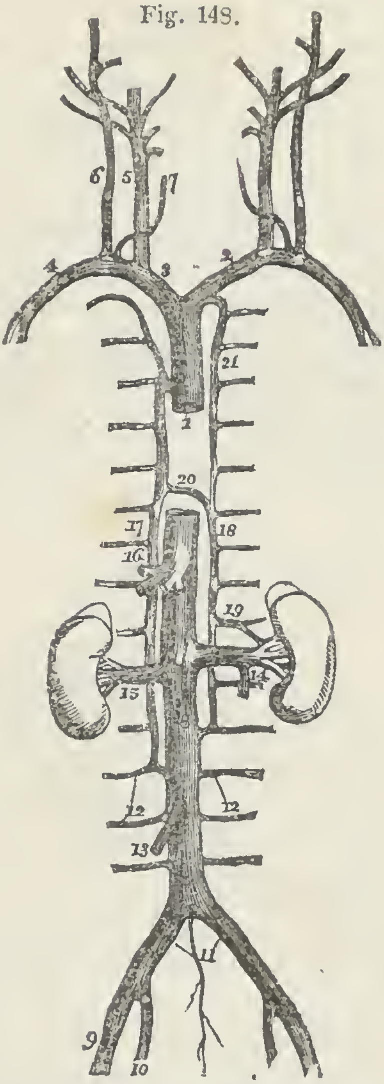


Fig. 146. The superficial veins on the inner side of the legs. 1, the saphena major at the inside of the knee; 2, a collateral branch of the saphena major on the leg; 3, the anastomosis of the veins below the knee; 4, the internal saphena at the middle of the calf of the leg; 5, the origin of the saphena vein at the ankle joint; 6, the anastomosing branch of the saphena major and minor; 7, branches on the back of the leg; 8, the great internal vein of the foot; 9, the arch of veins on the metatarsal bone; 10, a branch from the heel; 11, branches on the sole of the foot.

Fig. 147. The arteries and deep seated veins on the back of the leg. 1, The popliteal vein; 2, the popliteal artery; 3, 4, vein and artery in their relative positions on the back of the knee joint; 5, the popliteal vein on the inner side of the joint; 6, the popliteal artery without and beneath it; 7, the extremity of the saphena minor vein; 8, 9, the internal articular vessels, both arteries and veins; 10, 11, the external articular vessels, both arteries and veins; 12, the junction of the peroneal and posterior tibial veins; 13, a venous branch from the anterior tibial vein; 14, a vein from the gastrocnemius; 15, the anterior tibial artery coming through the interosseous ligament; 16, the posterior tibial artery; 17, its two attending veins; 18, the peroneal artery; 19, its two attending veins; 20, the vessels on the heel.

Fig. 148.



The veins of the trunk and neck. 1, The superior vena cava; 2, the left vena innominata; 3, the right vena innominata; 4, the right subclavian vein; 5, the internal jugular vein; 6, the external jugular; 7, the anterior jugular; 8, the inferior vena cava; 9, the external iliac vein; 10, the internal iliac vein; 11, the common iliac veins; the small vein between these is the vena sacra media; 12, 12, lumbar veins; 13, the right spermatic vein; 14, the left spermatic, opening into the left renal vein; 15, the right renal vein; 16, the trunk of the hepatic veins; 17, the greater vena azygos, commencing inferiorly in the lumbar veins; 18, the lesser vena azygos, also commencing in the lumbar veins; 19, a branch of communication with the left renal vein; 20, the termination of the lesser in the greater vena azygos; 21, the superior intercostal vein, communicating inferiorly with the lesser vena azygos, and terminating superiorly in the left vena innominata.

ANATOMY OF THE CAPILLARY VESSELS.

The CAPILLARIES constitute a microscopic net-work, which is so distributed through every part of the body, as

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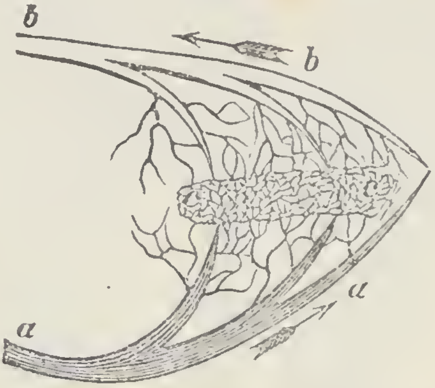
Describe the *capillary* vessels.

to render it impossible to introduce the smallest needle beneath the skin, without wounding several of these fine vessels. It is through the medium of the capillaries that the operations of nutrition and secretion are performed. They are remarkable for the uniformity of diameter, and for the constant divisions and communications which take place between them. They inosculate, on the one hand, with the terminal extremity of the arteries, and on the other, with the minute radicles or commencement of the veins. They are the connecting link between the arteries and veins. The inosculation of the capillaries, and their relation to the arterial and venous vessels, are illustrated in the following engraving.

Fig. 149.



a, *a*, an artery dividing into several branches, that terminate in capillaries, *c*, *c*; *b*, *b*, a venous trunk, formed from several small veins, that commence in the capillaries.

The double circulation of blood through the heart will be easily comprehended by carefully examining the following engraving. It would aid the student to examine the preceding engravings, representing the different parts of the heart.

What peculiar operations are performed in these vessels? For what are they remarkable? Describe fig. 149. What does Fig. 150 exhibit? How many pulmonary veins convey the blood from the lungs to the left auricle of the heart? How is the blood then conveyed to every part of the system?

Fig. 150.

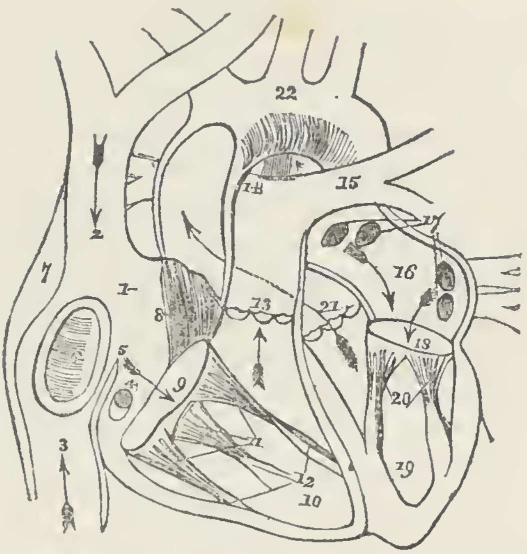


Fig. 150. 1, The right auricle; 2, the entrance of the superior vena cava; 3. the entrance of the inferior cava; 4, the opening of the coronary vein, half closed by the coronary valve; 5, the Eustachian valve; 6, the fossa ovalis, surrounded by the annulus ovalis; 7, the tuberculum Loweri; 8, the musculi pectinati in the appendix auriculæ; 9, the opening of the right auricle into the right ventricle; 10, the cavity of the right ventricle; 11, the tricuspid valves, attached by the chordæ tendineæ to the carneæ columnæ, (12); 13, the pulmonary artery, guarded at its commencement by three semilunar valves; 14, the right pulmonary artery, passing beneath the arch and behind the ascending aorta; 15, the left pulmonary artery, crossing in front of the descending aorta; *, the remains of the ductus arteriosus, acting as a ligament between the pulmonary artery and arch of the aorta. The arrows mark the course of the venous blood through the right side of the heart. Entering the auricle by the superior and inferior cavæ, it passes through the opening of the auricle into the ventricle, and thence through the pulmonary artery to the lungs. 16, The left auricle; 17, the openings of the four pulmonary veins; 18, the opening of the left auricle into the left ventricle; 19, the left ventricle; 20, the mitral valves, attached by their chordæ tendineæ to two large columnæ carneæ, which project from the walls of the ventricle; 21, the commencement and course of the ascending aorta behind the pulmonary artery, marked by an arrow. The entrance of the vessel is guarded by three semilunar valves. 22, The arch of the aorta. The comparative thickness of the two ventricles is shown in the diagram. The course of the pure blood through the left side of the heart is marked by arrows. The blood is brought from the lungs by the four pulmonary veins into the left auricle, and passes through the opening between the auricle and ventricle into the left ventricle, whence it is conveyed by the aorta to every part of the body.

PHYSIOLOGY OF THE HEART.

The walls of all the cavities of the heart are composed of muscular fibres, which are endowed with the property of contracting and relaxing, like other parts of the muscular system. The contraction and relaxation of the muscular tissue of the heart produce a diminution and

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Of what are the walls of the cavities of the heart composed?

enlargement of both auricular and ventricular cavities. These occur at every pulsation or beat of the heart.

The venous blood is poured from the ascending and descending cavas, fig. 150, 2, 3, into the right auricle, 1. When the right auricle contracts, the blood received from the cavas is forced through the opening, 9, into the ventricle, 10. When the right ventricle contracts, the right auricle dilates. At this moment, the tricuspid valves, 11, close the opening between the auricle and ventricle, and prevent the blood from reflowing into the auricle. The blood in the ventricle is pressed by ventricular contraction into the pulmonary artery, at 13 As soon as the ventricle has ejected the blood in its cavity into the artery, it dilates, and receives another amount of blood from the auricle. When the ventricle expands, the three semi-lunar valves, 13, close the orifice at the commencement of the pulmonary artery. This prevents the reflux of blood from the artery into the ventricle. The tricuspid valves will permit the blood to pass from the auricle into the ventricle, and the semilunar valves will also allow the blood to move from the ventricle into the artery, while both sets prevent a retrograde movement of the sanguineous fluid.

The blood in the pulmonary artery is distributed through the lungs, where it is purified, and returned through the pulmonary veins to the left auricle of the heart, 16. Then it is forced by the contraction of the muscular walls of the auricle, through the opening, 18, into the ventricular cavity, 19. The auricle then dilates to receive a fresh supply of blood from the pulmonary veins, while the ventricle contracts, and forces the blood lodged in its cavity into the aorta, 21. When the ventricle contracts, the mitral valves, 20, close the orifice between the auricle and ventricle, which prevents the reflow of blood into the auricle. When the ventricle dilates to receive another quantity of blood from the auricle, the semilunar valves of the aorta, 21, close the opening of this artery, and pre-

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What occurs at every pulsation of the heart? Into which auricle do the *cavas* pour their contents? Illustrate the circulation from the right auricle. Through what vessel is the venous blood carried to the lungs? How returned to the heart? From what source does the *left* auricle receive blood? Illustrate the circulation from the left auricle. The left ventricle.

vent the blood from flowing from the artery into the ventricle. Thus we see that the mitral valves permit the blood to pass from the auricle into the ventricle, and the semilunar valves likewise permit the blood to flow from the ventricle into the aorta, while both prevent its retrograde movement. If these valves are injured, or destroyed, the circulation will be as much disordered as the movements of a fire engine, or pump, by the destruction of its valves. Some of the most serious diseases of the heart, consist in a partial or complete destruction of these valves. Let the pupil draw a diagram of the heart upon the black-board, and from it explain the double circulation of the blood through it.

The right and left auricles contract simultaneously. When these contract, the right and left ventricles dilate. The dilatation of the ventricles is termed the *diastole* of the heart; their contraction, its *systole.*

The circulation of the fœtal heart is widely different from that of the adult. There is an opening in the partition between the two auricles, through which the blood passes from one auricle to the other. There is likewise an open canal, that connects the pulmonary artery at its bifurcation, 14, with the acrh of the aorta, 22, (Fig. 150.) Fig. 151 will give a good idea of the position and use of this canal, named the ductus arteriosus.

Soon after birth, the opening between the auricles is closed, and the ductus arteriosus is obliterated. While these continue open, the blood from the cavities of the right side of the heart passes into the aorta. In some instances, the opening between the auricles, and the communication between the pulmonary artery and aorta, are not closed at birth. This malformation is termed *cyanosis,* or *blue disease.* The closing of these apertures that the blood may be thrown into the lungs to be oxydated, and their remaining open prior to birth, when the pulmonary circulation is not needed, is one of the most curious and interesting operations performed in the system.

What is the difference between the circulation of the fœtal heart and that of an adult? What is the effect if the opening between the auricles and the canal connecting the pulmonary artery with the arch of the aorta is not closed? What is said of the closing of these apertures?

Fig. 151.

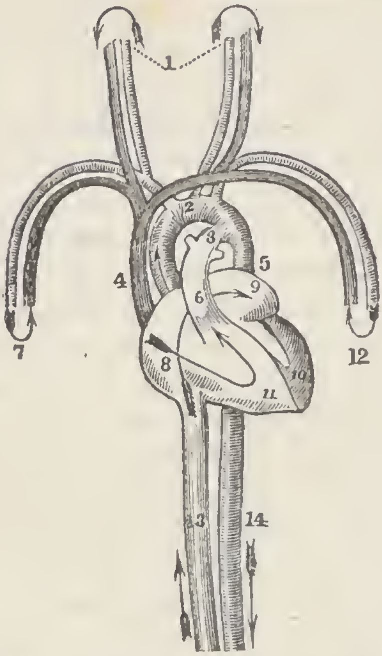

Fig. 151. The fœtal heart. 4, the descending vena cava; 13, the ascending vena cava; 8, the right auricle; 9, the left auricle; 10, the left ventricle; 11, the right ventricle; 2, the arch of the aorta; 5, the descending thoracic aorta; 14, the descending abdominal aorta; 6, the pulmonary artery; 3, the ductus arteriosus; 1, the carotid arteries. The blood in the descending and ascending cavas is thrown into the right auricle. From the right auricle a portion of the blood passes into the left auricle, through an opening in the partition between the two auricles. Another portion of the blood passes from the right auricle to the right ventricle. From the right ventricle the blood passes into the pulmonary artery, and through the ductus arteriosus into the aorta. The arrows indicate the course of the blood from one auricle to the other, and from the right auricle, through the right ventricle, into the pulmonary artery and ductus arteriosus. The arrows at the terminations of the arteries mark the return of blood from the arteries to the veins. Compare the passage of blood through the heart, Fig. 150 with 151.

PHYSIOLOGY OF THE ARTERIES, VEINS AND CAPILLARIES.

The blood is carried to and from the heart by the agency of the *arteries, veins* and *capillaries.* These vessels are found in every tissue of the system. They are necessary to the proper distribution of the blood. The relations of these vessels and the heart will be easily comprehended by attention to diagram 152.

The venous blood is carried from the right side of the heart, *c*, through the pulmonary artery, *d, d,* to the air cells in the lungs, x, x. Over the walls of these vesicles the pulmonary capillary vessels ramify. The blood is puri-

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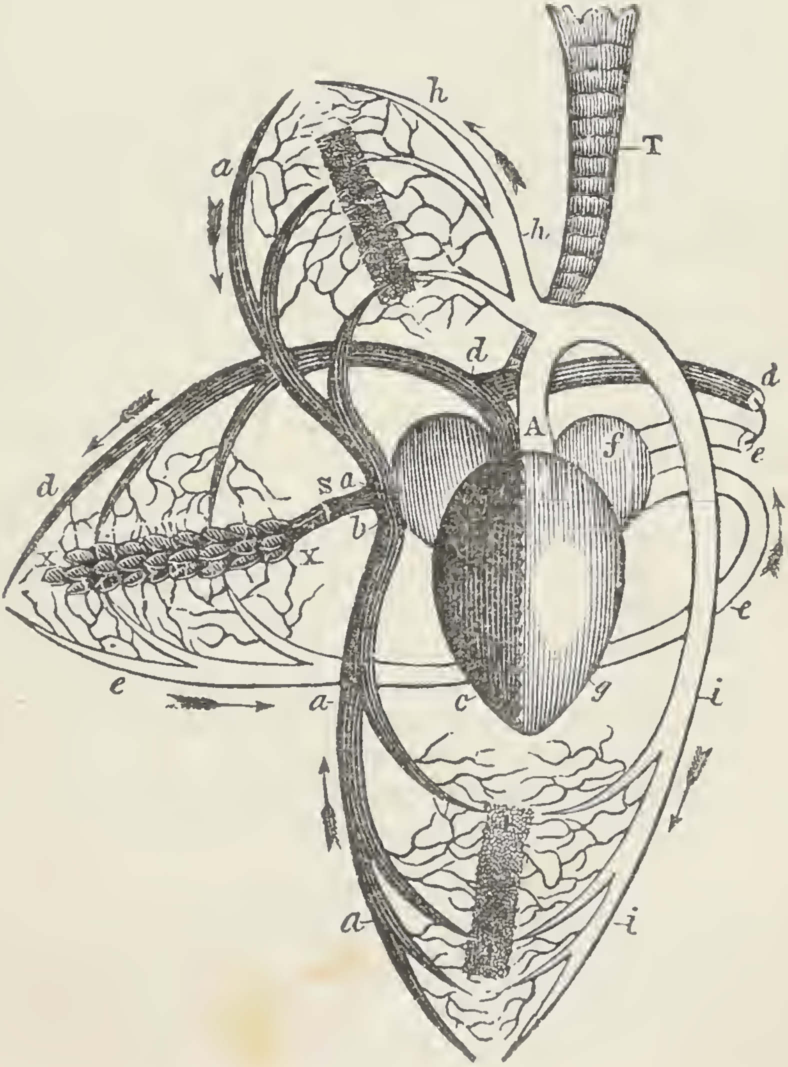
Through what agency is the blood carried to and from the heart? Describe the circulation of the venous blood in the heart and lungs. At what point is the blood purified?

fied in passing through the *capillaries*, from the pulmonary artery to the pulmonary vein, *e*, *e*, through which it is returned to the left auricle of the heart. From the left auricle the blood is carried to the left ventricle, *g*. From the left ventricle it is forced into the aorta, A. Through the branches of the aorta, *h*, *h*, and *i*, *i*, the purified blood is carried to every organ in the system. These arteries terminate in capillaries, 1, 1, 1, 1. Through these minute capillaries the blood is conveyed to the radicles of the veins. In the capillaries the blood loses its vermillion color, and becomes of a dark modena hue. From the capillaries the blood is returned to the right auricle of the heart, through the veins, *a*, *a*, *a*, *a*.

Fig. 152.



Explanation of Fig. 152.

T, the trachea ; *S*, a bronchial tube ; x, x, air vesicles, in which the bronchi terminate ; *a*, *a*, *a*, *a*, systemic veins, through which the unpure blood is returned to the right auricle ; *b*, the right auricle ; *c*, the right ventricle : *d*, *d*, *d*, the right and left pulmonary arteries ; *e*, *e*, *e*, the pulmonary veins ; *f*, the left auricle ; *g*, the left ventricle ; A, the aorta ; *h*, *h*, *i*, *i*, branches of the aorta. through which the blood is carried to the system ; 1, 1, 1, 1, capillary vessels in which the small arteries terminate, and in which the veins commence.

Let the student make a diagram upon the black board, of the *pulmonic* arteries and veins, and the *systemic* arteries and veins, with the relative positions of the air cells and capillary vessels; and from the diagram trace the pulmonic and systemic circulations.

The blood is carried from the heart in the arteries ; 1st, by the contraction of the muscular walls of the heart. The energy of the contraction of the heart varies in different individuals. It is likewise modified by the health and tone of the system. The power of the heart has been variously estimated, from four ounces to one hundred and eighty thousand pounds. It is probably equal to twelve pounds. 2nd. The contractile and elastic middle coat of the arteries renders important aid to the heart in impelling the blood to the minute vessels of the system. 3d. The peculiar action of the minute capillary vessels, is considered by some physiologists, to be of much importance as a motive power in the arterial circulation.

The blood is returned to the heart through the veins by the contraction of the venous coat, and the *vis a tergo*, or propulsive power of the heart, arteries, and capillary vessels. This is shown by the immediate arrestment of the blood which follows when these forces are suspended. There are concurrent causes which are supposed to have some influence upon the venous circulation. One is the suction power attributed to the heart, acting as a *vis a fronte*, in drawing blood towards it. Another important agency has been found ,by some physiologists, in the inspiratory movements, which are supposed to draw the blood of the veins in the chest, in order to supply the

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What is the relative position of the arteries and veins? How is the blood *first* impelled from the heart to the arteries? Does the contractile energy of the heart vary? What are the estimates of the power of the heart? How do the arteries aid the heart in impelling the blood through the system? How is the venous blood returned to the heart? What are the concurrent causes which are supposed to influence the venous circulation?

vacuum which is created there by the elevation of the ribs and the descent of the diaphragm.

One of the most powerful causes which influence the venous circulation, is the frequent-recurring action of the muscles upon the venous trunks. When the muscles are contracted, they compress that portion of the veins which lie beneath their contracted bellies, and thus force the blood from one valve to the other, towards the heart. When they are relaxed, the veins refill, and are compressed by the recurring action of the muscles.

The muscles exercise an agency, in maintaining the venous circulation at a point above what the heart could perform. As the pulsations are diminished by rest, so they are accelerated by exercise, and very much quickened by violent effort. There can be little doubt that the increased rapidity of the return of blood through the veins, is of itself a sufficient cause for the accelerated movements of the heart. When a large number of muscles are called into action after repose, as when we rise from a recumbent or sitting posture, the blood is driven to the heart with a very strong impetus. If that organ should be diseased, it may arrive there in a larger quantity than can be disposed of, and death may be the result. Hence the necessity for the avoidance of all sudden and violent movements, on the part of those who have either a functional or structural disease of the heart.

THE BLOOD.

The blood is composed of two parts;—a watery fluid, called *serum;* and a solid portion, called the *coagulum*, or *clot*. The coagulum contains concreted *albumen;* a white substance which forms on the upper surface, called *fibrine;* and red globulated matter, which is found on its lower surface. The color of the red globules is owing to the presence of iron, though some physiologists think it depends on an animal substance of a gelatinous character.

The blood is not necessarily red. It may be white, as

What is one of the most powerful causes that influence venous circulation? Describe the action of the muscles upon the veins, in impelling the venous blood. What rule is given for those who may have a disease of the heart? Why this precaution? Of how many parts is the blood composed? How is the coagulum formed? Of what color is the blood of the fish?

in the fish; transparent, as in the insect; or yellowish, as in the reptile. There is no animal in which the blood is red in all parts of the body. The ligaments and tendons in man, are not supplied with red, but with white blood.

Ordinarily a complete circulation of the blood is effected every three minutes. The pulsations number, or the pulse beats, seventy-five times in a minute in an adult, one hundred and forty in an infant, and in old age about sixty. The blood constitutes about one-fifth part of the weight of the whole body; as about two ounces are expelled at each contraction of the ventricles, thirty-five pounds, on an average, must pass through the heart every three minutes, seven hundred pounds every hour, and sixteen thousand pounds, or eight tons, every twenty-four hours.

PRACTICAL SUGGESTIONS.

1st. If any part of the system be deprived of blood, its vitality will cease; but if the blood be diminished in quantity to a limited extent, only the vigor and health of the part will be impaired. 2nd. If the constituent elements of the blood be changed, or in other words, if the blood becomes impure, the functional action of the different organs of the system will be deranged, and acute disease may be induced.

The following conditions, if observed, would favor the free and copious supply of blood to all parts of the system.

1st. Wear the clothing loosely on *every part of the system*, as compression of any kind impedes the passage of blood through the vessels of the compressed part. The observance of this condition is particularly important in regard to the chest, as this cavity contains the lungs, heart, large arteries and veins.

The blood which passes to and from the brain, travers-

Of what color is the blood of the insect? The reptile? What part of the human system has white blood? How often is there a complete circulation of the circulating fluid? In an adult, how many pulsations in a minute? The infant? In old age? How many ounces of blood are expelled at each contraction of the ventricles? How much every hour? Every twenty-four hours? What is the effect if any part of the system be deprived of blood? If the blood be diminished in quantity? What is the effect upon the system when the blood becomes impure? Why should the clothing on every part of the system be loosely worn?

es the vessels of the neck. If the dressing of this part be close, the circulation will be impeded, and the functions of the brain will be impaired. This remark is particularly important to scholars, public speakers, individuals predisposed to apoplexy and other diseases of the brain.

As many of the large veins lie immediately beneath the skin, through which the blood is returned from the lower extremities, if the ligatures used to retain the hose, or any other article of apparel, in proper position, should be tight, the passage of blood through these vessels would be obstructed, producing, by their distension, the varicose or enlarged veins. Hence, *elastic* bands should be used for these purposes.

2nd. The temperature of all parts of the system should be as equal as possible, as a chill on one portion of the body diminishes the calibre of its blood vessels, and the blood, which should distend and stimulate the chilled part, will accumulate in other organs. The deficiency of blood in the chilled portion induces weakness, while the superabundance of sanguineous fluid may cause disease in another part of the system.

The skin should be kept not only of an equal temperature, but the warmth of it should be so maintained, by adequate clothing, that no chill shall produce a contraction of the circulating vessels and a consequent paleness. If the skin be not kept warm, the blood will recede from the surface of the body, and accumulate in the internal organs. Cleanliness of the skin and clothing, is likewise demanded, for the reason, that this condition favors the free action of the cutaneous vessels.

3d. The action of the muscles is one of the important forces which impel the blood through the arteries and veins. Hence, daily and regular exercise of the muscular system, is required, to sustain a vigorous circulation in the extremities and skin, and also to maintain a healthy condition of the system. The best stimulants to improve the sluggish circulation of an indolent patient,

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To whom is the tight dressing of the neck particularly injurious? Why? Why should the temperature of every part of the system be nearly equal? What effect will be produced if the skin be not kept warm? Why should the muscular system be regularly exercised? What are the best stimulants for sluggish circulation in indolent persons?

whose skin is pale and whose extremities are cold, are the union of vigorous muscular exercise with agreeable mental action, and the systematic application to the skin of cold water, attended with friction in bathing.

2. To maintain the blood of the system in a state of purity, requires attention to the practical suggestions upon the skin, muscles, digestion, and lungs, (*see these different sections.*)

If the blood has become 'impure,' or 'loaded with humors,' (an idea generally prevalent,) it is not and cannot be 'purified,' by taking, 'ad libitum,' patent pills, powders and drops. The blood may become impure by retention of the waste product, which should have been eliminated from the system by the agency of the cutaneous vessels, which have become inactive. This inactivity may be produced by improper and inadequate clothing, or by a want of cleanliness, as explained in the chapter on the skin. The only successful method to be pursued for the purifying of the blood and the restoration of health in this case, is to observe the directions given relative to clothing and bathing, in Chap. II.

The blood may be made impure, by the chyle being deficient in quantity, or defective in quality. This state of the chyle may be produced by the food being improper in quantity, or quality, or by its being taken in an improper manner, at an improper time, and when the system is not prepared for it. The remedy for impure blood produced in any of these ways is to correct the injudicious method of using food, by observing the suggestions in Chap. VI.

Again, the blood may be rendered impure, by not supplying it with oxygen in the lungs, and by the carbonic acid gas not being eliminated from the system through this channel. The remedy for 'impurities of the blood,' produced in this manner, would be, to carefully reduce to practice the directions under the head of 'practical suggestions,' in the chapter on the respiratory organs, relative to the free movements of the ribs and diaphragm, and the proper ventilation of rooms.

Will patent pills and powders purify the blood if the cutaneous vessels are inactive? Give some of the remedies for impurity of the blood.

CHAPTER X.

THE NERVOUS SYSTEM.

The nervous system consists of a central organ, the cerebro-spinal axis or centre, and of numerous rounded and flattened white cords, called nerves, which are connected, by one extremity, with the cerebro-spinal centre, and by the other distributed to all the textures of the body. The sympathetic system is an exception to this description; for, instead of one, it has many small centres, which are called ganglia, and which communicate very freely with the cerebro-spinal axis, and with its nerves.

The cerebro-spinal axis consists of two portions — the *brain*, and the *spinal cord.* For convenience of description, the nervous system may be divided into — 1, the brain; 2, the cranial nerves; 3, the spinal cord; 4, the spinal nerves; 5, the sympathetic nerve.

ANATOMY OF THE BRAIN.

The brain is a collective term, which signifies those parts of the nervous system, exclusive of the nerves themselves, which are contained within the cranium, or skull bones; they are the *cerebrum*, *cerebellum*, and *medulla oblongata.* These are invested and protected by the membranes of the brain. The whole together constitute the *encephalon*, from the Greek, *eg*, in, and *kephale*, head.

The membranes of the brain are the *dura mater*, *arachnoid*, and *pia mater*.

The DURA MATER is a firm, fibrous membrane, which is exposed on the removal of the *calvarium*, or section of the skull bones. This lines the interior of the skull and

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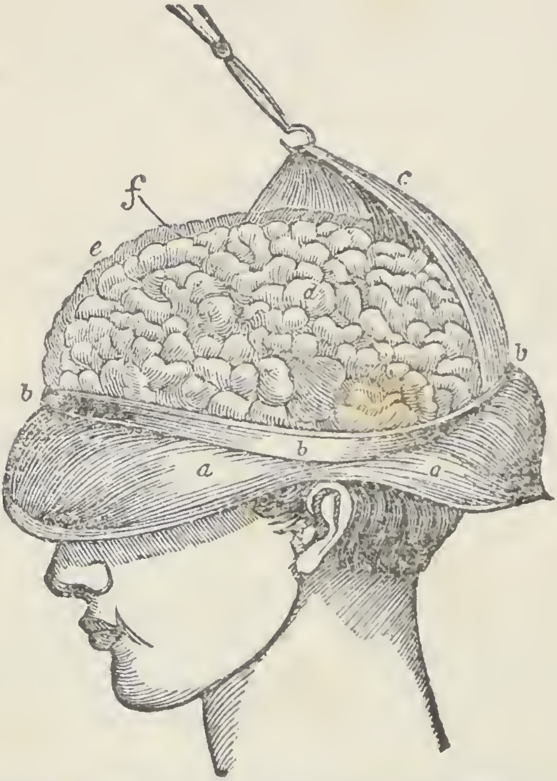
Of what does the nervous system consist? What constitutes an exception to this? How is the nervous system divided? Describe the brain. How many membranes has it? Describe the *dura mater*. What is its use?

spinal column, and likewise sends processes inward, for the support and protection of the different parts of the brain. It also sends processes externally, which form the sheaths for the nerves, as they quit the skull and spinal column. The dura mater is supplied with arteries and nerves.

The ARACHNOID, or spider's web membrane, so named from its extreme tenuity, is the serous membrane of the cerebro-spinal centre, and, like other serous membranes, a shut sac. It envelopes the brain and spinal cord, and is reflected upon the inner surface of the dura mater, giving to that membrane its serous investment. There are no vessels in the arachnoid, and no nerves have been traced into it.

Fig. 153.



a, *a*, the scalp turned down; *b*, *b*, *b*, the cut edge of the bones of the skull; *c*, the external strong membrane of the brain, the *dura mater* suspended by a hook; *d*, the left hemisphere of the brain, showing its convolutions; *e*, the superior edge of the right hemisphere; *f*, fissure between the two hemispheres.

The PIA MATER is a vascular membrane, composed of

Describe the *arachnoid* membrane. What is one of its uses? Describe the *pia mater*.

innumerable vessels, held together by cellular membrane. It invests the whole surface of the brain, and dips into its convolutions. The pia mater is the nutrient membrane of the brain, and receives its blood from the carotid and vertebral arteries. Its nerves are minute branches of the sympathetic, which accompany the branches of the arteries.

Fig. 154.

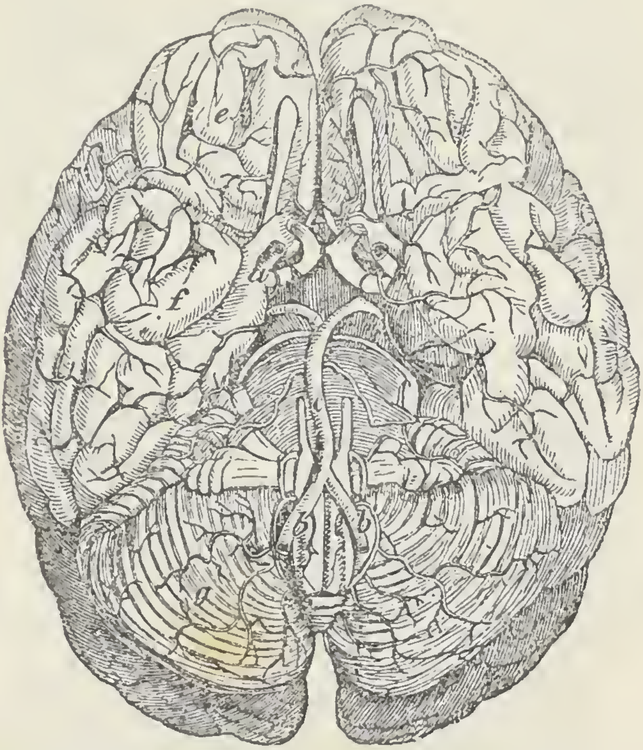


Fig. 154 represents the base of the cerebrum and cerebellum; *e*, is the anterior lobe that lies over the orbits of the eyes; *f*, is the middle lobe; *g*, the cerebellum; the anterior and middle lobes of the cerebrum have their convolutions represented, while, in the cerebellum, the laminæ are distinctly seen. *a*, the carotid artery; *b*, *b*, the vertebral arteries; *c*, the basilar artery, formed by the union of the vertebral arteries. These are the vessels which supply the brain with blood.

THE CEREBRUM.

The CEREBRUM is divided into two hemispheres, by a cleft, or fissure. Into this cleft dips a portion of the dura mater, named the *falx cerebri*, from its resembling a sickle. The design of this membrane seems to be to relieve the one side from the pressure of the other, when the head is reclining to either side. Upon the superior

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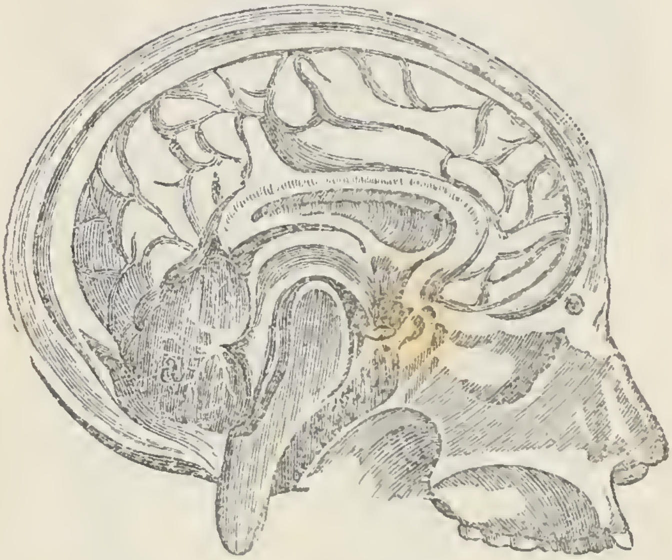
Which membrane nourishes the brain? How is the *cerebrum* divided. What is the use of the falx cerebri?

surface of the cerebrum, are seen undulating windings, named convolutions. Upon its inferior surface, each hemisphere admits of a division into three lobes — the anterior, middle, and posterior.

If the upper part of the hemispheres be removed horizontally with a scalpel, a centre of white substance will be observed. This is surrounded by a border of gray, which follows the depressions of the convolutions, and presents a zigzag outline. The divided surface will be seen to be studded with numerous small, red points, which are produced by the escape of blood from the divided ends of the minute arteries and veins. The gray border is named the cortical, or cineritious portion. The *corpus callosum* is a dense layer of transverse fibres, connecting the two hemispheres.

Fig. 155.



This is an exhibition of a vertical section of the bones of the head, face, and brain, showing precisely the appearance, were the head divided in the middle, from the top down to the neck. Letters of reference to the various parts have not been introduced, because the cut will be doubly valuable, when the general relation of the different portions have been learned from the text, and the other diagrams. The reader will then trace, with his eye, the outline of the little brain, marked *a*. In this cut, the medullary matter is arranged in the form of the trunk and branches of a tree. The ventricles and other interesting points are intricate, yet the manifest design of them will repay the student for his investigations. The mechanical arrangement only, is contemplated in this figure.

What is seen upon the superior surface of the brain? Its inferior? Describe the appearance of the brain when a horizontal section has been made. What is the gray border often called? What connects the hemispheres?

Fig. 156.

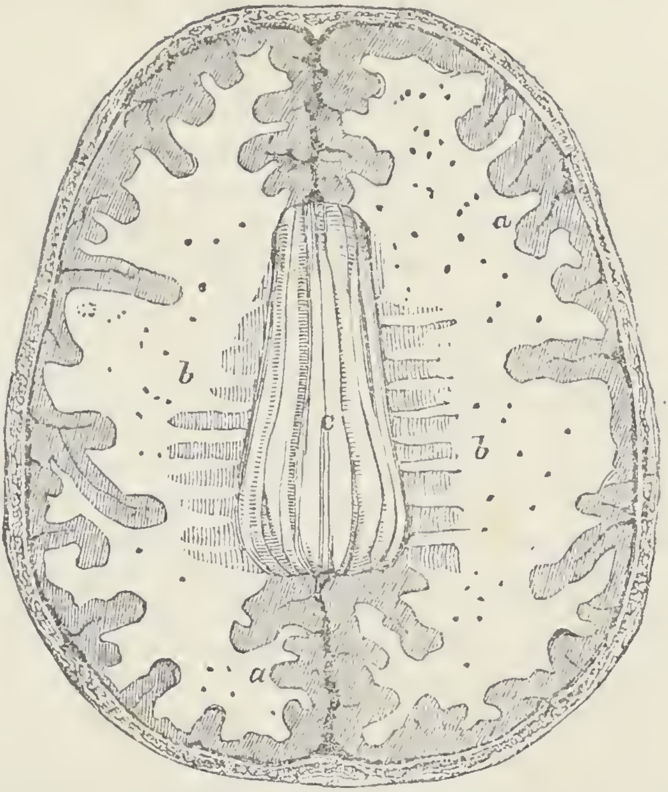


Fig. 156 represents a horizontal section of the bones of the skull and brain; *a*, *a*, represents the outer layer, of ash-colored matter; *b*, *b*, the white, medullary, central part of brain; *c*, the corpus callosum. The dots in the white portion indicate the situation of the divided arteries.

THE CEREBELLUM.

The CEREBELLUM is about seven times smaller than the cerebrum. Like that organ it is composed of white and gray matter, but the gray constitutes the largest portion. Its surface is formed of parallel laminæ, separated by fissures. The white matter is so arranged, that when cut vertically, the appearance of the trunk and branches of a tree is presented. Hence it is named *arbor vitæ*. It is situated under the posterior lobe of the cerebrum, from which it is separated by a process of the dura mater, named the *tentorium*.

The MEDULLA OBLONGATA, or that portion of the spinal cord which is within the skull, consists of three pairs of

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How does the *cerebellum* compare in size with the cerebrum? What is its appearance when cut vertically? Where is the cerebellum or little brain situated? Describe the *medulla oblongata*.

bodies united in a single bulb, namely, the *corpora pyramidalia*, *corpora olivaria*, and *corpora restiformia*. (See Figs. 157, 163.)

The brain is of a pulpy character, quite soft, in infancy and childhood; but it gradually becomes more and more consistent, and in middle age it assumes the form of determinate structure and arrangement. It is more abundantly supplied with blood than any organ of the system. No absorbents have been detected in this organ.

PHYSIOLOGY OF THE BRAIN.

The brain is regarded, by physiologists and philosophers, as the organ of the mind. Most writers consider it as an aggregate of parts, each charged with specific functions, and that these functions are the highest and most important in the animal economy. To the large brain, or cerebral lobes, they ascribe the seat of the faculties of *thinking*, *memory*, and *the will*. To the cerebellum or little brain, the seat of the *animal* or *lower propensities*.

The constant relation between mental power and developement of brain, explains why capacities and dispositions are so different, and shows incontrovertibly, that the cultivation of the moral and intellectual faculties can be successfully carried on only by acting in obedience to the laws of organization, and associating together those faculties the organs of which are simultaneously progressive in that growth. In infancy, for example, the intellectual powers are feeble and inactive; this arises solely from the inaptitude of a still imperfect brain; but in proportion as the latter advances towards its mature state, the mental faculties also become vigorous and active.

The brain likewise holds an important relation to all the other organs of the system. To the muscular system it imparts a fluid which induces contraction of the fibres. By this relation they are brought under the control of the will. The digestive, respiratory, and circulatory appara-

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What is the character of the brain in childhood? In adults? Have absorbent vessels been detected in this organ? How is the brain regarded by physiologists and philosophers? What do they ascribe to the cerebrum? To the cerebellum? What does the relation between mental powers and developement of brain explain?

tus is enabled to perform its functions by the fluid imparted to it by the cerebral organ of the nervous system.

PRACTICAL SUGGESTIONS.

As the different organs of the system are dependent on the cerebro-spinal axis, for efficient functional action, and as the mind and brain are closely associated during life, the former acting in strict obedience to the laws which regulate the latter, it becomes an object of primary importance in education, to discover what these laws are, that we may yield them willing obedience, and escape the numerous evils consequent on their violation.

'As the brain is subject to the same general laws as other organs of the system, we say that a sound, original constitution is the FIRST condition of its healthy action. If the brain from birth be free from all hereditary taints and imperfections, and has acquired no unusual susceptibility from injudicious treatment in infancy, it will resist a great deal in after life, before its health will yield. But if, on the other hand, it has inherited deficiencies, or early mismanagement has subsequently detailed upon it an unusual proneness to morbid action, it will yield under circumstances which would otherwise have been perfectly innocuous. Accordingly, it may truly be said that the most powerful of all causes which *predispose* to nervous and mental disease, is the transmission of a *hereditary* tendency from parents to children, producing in the latter an unusual liability to the maladies under which the parents have labored.

Even where the defect in the parent is merely some peculiarity of disposition or temper, amounting, perhaps, to eccentricity, it is astonishing how clearly its influence on some one or other of the progeny, may often be traced, and how completely a constitutional bias of this description may interfere with a man's happiness or success in life. We have seen instances in which it pervaded every mem-

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If the mind and brain be closely associated, what becomes an object of primary importance in education? What is the *first* condition of the healthy action of the brain? Why? Illustrate this. In what case of minor importance may this hereditary influence be evinced?

ber of a family, and others in which it affected only one or two. When the original eccentricity is on the mother's side, and she is gifted with much force of character, the evil extends more widely among the children, than when it is on the father's side. Where both parents are descended from tainted families, the progeny is, of course, more deeply affected, than where one of them is from a pure stock. Seemingly for this reason, hereditary predisposition is a more usual cause of nervous disease in the higher classes, who intermarry much with each other, than in the lower, who have a wider choice.

Unhappily, it is not merely as a cause of disease, that hereditary predisposition is to be dreaded. The obstacles which it throws in the way of permanent recovery, are even more formidable, and can never be entirely removed. Safety is to be found only in avoiding the perpetuation of the mischief. Therefore, if two persons, each naturally of excitable and delicate nervous temperament, choose to unite for life, they have themselves to blame for the concentrated influence of similar tendencies in destroying the health of their offspring, and subjecting them to all the miseries of nervous disease, madness, or melancholy. *The command of God not to intermarry within certain degrees of consanguinity, is in accordance with the organic law of the brain, and the wisdom of the prohibition is confirmed by correct observation.*

The SECOND condition required for the health of the brain, is, a due supply of properly oxygenated blood. The effects of slight differences in the quality of the blood, are not easily recognized, but, when they exist in an extreme degree, the effects are too obvious to be overlooked. If the stimulus of arterial blood be altogether withdrawn, the brain ceases to act, and sensibility and consciousness become extinct. Thus when fixed air is inhaled, the blood circulating through the lungs does not undergo that process of oxygenation which is essential to

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If the defect be on the side of the mother? The effect if both parents have the same hereditary taints? What is one cause of nervous diseases among the higher classes? Why is hereditary predisposition to be dreaded? What is the *second* condition required for the health of the brain? What effects arise from differences in the quality of the blood? Give another instance of the injurious effects of impure blood.

life. As it is in this state unfit to excite or support the action of the brain, the mental functions become impaired, and death closes the scene. If, on the other hand, the blood be too highly oxygenated, — as by breathing oxygen gas instead of common air, the brain is too much stimulated, and an intensity of action, bordering on inflammation, takes place, which also soon terminates in death.

Such are the consequences of the two extremes; but the slighter variations in the state of the blood, have equally sure, though less palpable effects. If its vitality be impaired by breathing an atmosphere so much vitiated as to be insufficient to produce the proper degree of oxygenation, the blood then affords an imperfect stimulus to the brain. As a necessary consequence, languor and inactivity of the mental and nervous functions ensue, and a tendency to headache, fainting, or hysteria, makes its appearance. This is every day seen in the listlessness and apathy prevalent in *crowded and ill-ventilated school-rooms; and in the headaches and liability to fainting, which are so sure to attack persons of a delicate habit, in the contaminating atmospheres of crowded theatres, churches, and assemblies.* It is less strikingly, but more permanently exhibited, in the irritable and sensitive condition of the inmates of cotton manufactories and public hospitals. In these instances, the operation of the principle cannot be disputed; for the languor, and nervous debility consequent on confinement in ill-ventilated apartments, or in air vitiated by the breath of many people, are neither more nor less than minor degrees of the same process of poisoning, to which we have formerly alluded. (*See Physiology of Digestion and Respiration.*) It is not real debility which produces them; for egress to the open air almost instantly restores activity to both mind and body, unless the exposure has been very long, in which case more or less time is required to re-establish the exhausted powers of the brain. A good deal of observation has convinced us, that the transmission of imperfectly oxygenated blood

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What effects are produced by slighter variations in the quality of the blood? Mention instances where this is commonly evinced. Why is the operation of the principle in these instances indisputable? Show why real debility is not the cause.

to the brain, is much more influential in the production of *nervous disease* and delicacy of constitution, than is commonly imagined.

The THIRD condition of health in the brain and nervous system, is, the regular exercise of their respective functions.

The brain, being an organized part, is subject, so far as regards exercise, to the same laws as the other organs of the body. If it be doomed to inactivity, its health will decay, and the mental operations and feelings, as a necessary consequence, will become dull, feeble, and slow. If it be duly exercised, after regular intervals of repose, the mind will acquire readiness and strength. Lastly, if it be overtasked, either in the force or the duration of its activity, its functions will become impaired, and irritability and disease will take the place of health and vigor.

The consequence of *inadequate* exercise will first be explained. We have seen that by disease the muscles become emaciated, the bones soften, and the blood-vessels are obliterated. The brain is no exception to this general rule. It is impaired by permanent inactivity, and becomes less fit to manifest the mental powers with readiness and energy. Nor will this surprise any reflecting person who considers that the brain, as a part of the same animal system, is nourished by the same blood, and regulated by the same vital laws, as the muscles, bones, and arteries.

It is the weakening and depressing effect which is induced by the absence of the stimulus necessary for the healthy exercise of the brain, that renders solitary confinement so severe a punishment, even to the most daring minds. Keeping the above principle in view, we shall not be surprised to find that *non-exercise* of the brain and nervous system, or in other words, inactivity of intellect and feeling, is a very frequent predisposing cause of every form of nervous disease. For demonstrative

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What is the *third* condition of health in the brain and nervous system? What is the effect if the brain be not duly exercised? If it be duly exercised? If it be overtasked? What is the consequence of disuse of the organs mentioned in preceding chapters? Does the same principle apply to the brain? Why? What renders solitary confinement so severe a punishment to the most daring minds? What is a predisposing cause of nervous disease?

evidence of this position, we have only to look at the numerous victims to be found among females of the middle and higher ranks, who have no calls to exertion in gaining the means of subsistence, and no objects of interest on which to exercise their mental faculties, and who consequently sink into a state of mental sloth and nervousness, which not only deprives them of much enjoyment, but subjects them to suffering, both of body and mind, from the slightest causes.

But let the situation of such persons be changed; bring them, for instance, from the listlessness of retirement, to the business and bustle of the city; give them a variety of imperative employments, and so place them in society as to supply to their cerebral organs that extent of exercise which gives health and vivacity of action, and in a few months, the change produced will be surprising. Health, animation, and energy will take the place of former insipidity and dulness. An additional illustration involving an important principle in the production of many distressing forms of disease, will be found in the case of a man of mature age, and of active habits, who has devoted his life to the toils of business, and whose hours of leisure have been few and short. Suppose such a person to retire to the country in search of repose, and to have no moral, religious, or philosophical pursuits to occupy his attention, and keep up the active exercise of his brain,—this organ will lose its health, and the inevitable result will be weariness of life, despondency, or some other variety of nervous disease.

One great evil attending the absence of some imperative employment, or object of interest, to exercise the mind and brain, is the tendency which it generates to waste the mental energies on every trifling occurrence which presents itself, and to seek relief in the momentary excitement of any sensation, however unworthy. The best remedy for these evils is to create occupation to interest the mind, and give that wholesome exercise to the brain, which its constitution requires.

In what classes do mental and nervous debility prevail? How can this be counteracted? Give another illustration showing how disease of the brain is induced. What is one great evil attending the absence of some imperative employment to exercise the mind and brain? What is the true remedy for these evils?

The evils arising from *excessive* or ill-timed exercise of the brain, or any of its parts, are numerous, and equally at variance with the ordinary laws of physiology. When we use the eye too long, or in too bright a light, it becomes blood-shot. The increased action of its vessels and nerves, gives rise to a sensation of fatigue and pain, requiring us to desist. If we turn away the eye, the irritation gradually subsides, and the healthy state returns. But, if we continue to look intently, or resume our employment before the eye has regained its natural state by repose, the irritation at last becomes permanent, and disease, followed by weakness of vision, or even blindness, may ensue.

Phenomena precisely analogous occur, when, from intense mental excitement, the brain is kept long in a state of excessive activity. The only difference is, that we can always see what happens in the eye, but rarely what takes place in the brain; occasionally, however, cases of fracture of the skull occur, in which from part of the bone being removed, we *can* see the quickened circulation in the vessels of the brain, as easily as in those of the eye. Sir Astley Cooper had a young gentleman brought to him, who had lost a portion of his skull just above the eye-brow. 'On examining the head,' says Sir Astley Cooper, 'I distinctly saw that the pulsation of the brain was regular and slow; but at this time he was agitated by some opposition to his wishes, and directly the *blood was sent with increased force to the brain, and the pulsation became frequent and violent.*' In many instances, indeed, the increased circulation in the brain, attendant on high mental excitement, reveals itself when least expected, and leaves traces after death, which are but too legible. When tasked beyond its strength, the eye becomes insensible to light, and no longer conveys any impressions to the mind. In like manner, the brain, when much exhausted, becomes incapable of thought, and consciousness is almost lost in a feeling of utter confusion.

At any time of life, excessive and continued mental

From what other cause do evils arise to the brain? Explain it by the excessive use of the eye. What is the only difference in the analogy of the phenomena of the eye and brain? Has the analogy been verified? Relate the case detailed by Sir Astley Cooper. Is excessive and continued mental exertion hurtful at any age?

exertion is hurtful; but in infancy and early youth, when the structure of the brain is still immature and delicate, permanent mischief is more easily inflicted by injudicious treatment than at any subsequent period. In this respect, the analogy is complete between the brain and the other parts of the body, which has been exemplified in the injurious effects of premature exercise of the bones and muscles. Scrofulous and rickety children are the most usual sufferers in this way. They are generally remarkable for large heads, great precocity of understanding, and small, delicate bodies. But in such instances, the great size of the brain, and the acuteness of the mind, are the results of morbid growth. Even with the best of management, the child passes the first years of its life constantly on the brink of active disease. Instead, however, of trying to repress its mental activity, the fond parents, misled by the early promise of genius, too often excite it still farther, by unceasing cultivation, and the never-failing stimulus of praise. Finding its progress, for a time, equal to their warmest wishes, they look forward with ecstasy, to the day when its talents will break forth, and shed lustre on its name. But in exact proportion as the picture becomes brighter to their fancy, the probability of its being realized becomes less; for the brain, worn out by premature exertion, either becomes diseased, or loses its tone, leaving the mental powers imbecile and depressed for the remainder of life. The expected prodigy is thus easily outstripped, in the social race, by many whose dull outset promised him an easy victory.

Taking for our guide the necessities of the constitution, it will be obvious that the modes of treatment commonly resorted to, ought to be reversed. Instead of straining to the uttermost, the already irritable powers of the precocious child, and leaving his dull competitor to ripen at leisure, a systematic attempt ought to be made, from early infancy, to rouse to action the languid faculties of the latter, while no pains ought to be spared, to moderate and give tone to the activity of the former. Instead of

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At what age particularly so? What is said of scrofulous and rickety children? What is the cause of their early promise and their subsequent disappointment? What mode of treatment should be adopted?

this, however, the prematurely intelligent child is sent to school, and tasked with lessons, at an unusually early age; while the healthy, but more backward boy, who requires to be stimulated, is kept at home, in idleness, perhaps for two or three years longer, merely on account of his backwardness. A double error is here committed. The consequences to the clever boy, are frequently the permanent loss, both of health and of his envied superiority of intellect.

In youth, too much mischief is done by the long, daily period of attendance at school, and the continued application of mind, which the ordinary system of education requires. The law of exercise, that long-sustained action exhausts the vital powers of the organ, applies as well to the brain as to the muscles. Hence the necessity of varying the occupations of the young, and allowing frequent intervals of exercise in the open air, instead of enforcing the continued confinement, now so common.

In early and middle life, fever, with an unusual degree of cerebral disorder, is a common consequence of the excessive and continued excitement of the brain. This unhappy result is brought on by severe study, unremitted mental exertion, anxiety, and watching.

Nervous disease, from excessive mental labor, and exaltation of feeling, sometimes shows itself in another form. From the want of proper intervals of rest, the vascular excitement of the brain, which always accompanies activity of the mind, has not time to subside. A restless irritability of temper and disposition comes on, attended with sleeplessness and anxiety, for which no external cause can be assigned. The symptoms gradually become aggravated, the digestive functions give way, nutrition is impaired, and a sense of wretchedness is constantly present, which often leads to attempts at suicide. Having pointed out the evils arising, both from inadequate and from excessive mental exertion, it remains to direct

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How should the dull or less active child be treated? What is the usual course? What is the consequence of the error? What error prevails in the present system of education? Why should youths be allowed frequent intervals, to exercise in the open air? What is a frequent consequence of continued and excessive excitement of the brain? Under what form do nervous diseases sometimes manifest themselves, from excessive mental labor?

the attention to some of the rules which should guide us in the proper exercise of the brain.

1*st.* It seems to be a law of the animal economy, that when two classes of functions are called into vigorous action at the same time, one or both will sooner or later sustain injury. Hence, the important rule, never to enter upon continued mental exertion, or to arouse deep feeling, immediately after a full meal, as the activity of the brain is sure to interfere with that of the stomach, and disorder its functions. Even in a perfectly healthy person, unwelcome news, sudden anxiety, or mental excitement, occurring soon after eating, will impede digestion, and cause the stomach to loathe the masticated food. In accordance with this rule, we learn, by experience, that the worst forms of indigestion and nervous depression, are those which arise from excessive application of mind, or turmoil of feeling, conjoined with unrestrained indulgence in the pleasures of the table. In such circumstances the stomach and brain react upon and disturb each other, till all the horrors of nervous disease make their unwelcome appearance, and render life miserable. Literary men and students know this fact from sad experience.

2*d.* The time best adapted for mental exertion is next to be considered. Nature has allotted the darkness of night for repose, and for the restoration, by sleep, of the exhausted energies of mind and body. If study or composition be ardently engaged in towards that period of the day, the increased action of the brain, which always accompanies activity of mind, requires a long time to subside. If the individual be at all of an irritable habit of body, he will be sleepless for hours after he has retired, or perhaps be tormented by unpleasant dreams. It is, therefore, of great advantage to engage in severe studies early in the day, and to devote several of the hours which precede bedtime, to lighter reading, music, or conversation. The vascular excitement previously induced in the head by study, has then time to subside, and sound, refreshing sleep is much more certainly obtained. This rule is of

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What is a law of the animal economy? What rule is here given? How are the worst forms of indigestion and nervous depression produced? What class of men experience this fact? What evils arise from studious application at night? When should the student pursue the abtruse, and when the lighter studies? For what reason?

great consequence to those who are obliged to undergo much mental labor.

3*d.* PERIODICITY, or a tendency to resume the same mode of action at stated times, is peculiarly the characteristic of the nervous system. On this account, *regularity* is of great consequence in exercising the moral and intellectual powers. If we repeat any kind of mental effort, every day, at the same hour, we at last find ourselves entering upon it, without premeditation, when the time approaches. In like manner, if we arrange our studies in accordance with this law, and take up each in the same order, a natural aptitude is soon produced, which renders application more easy than by resuming the subjects as accident may direct.

4*th.* The necessity of judicious REPETITION, in mental and moral education, is, in fact, too little adverted to, because the principle which renders it efficacious has not been understood. To induce facility of action in the organs of the mind, *practice* is as essential as it is in the organs of motion.

In physical education, we are aware of the advantages of repetition. We know that if practice in dancing, fencing, skating, and riding, is persevered in for a length of time sufficient to give the muscles the requisite promptitude and harmony of action, the power will be ever afterwards retained, although little called into use; whereas, if the muscles have not been duly trained, we may reiterate practice at different intervals, without proportionate advancement. The same principle applies equally to the moral and intellectual powers, because these operate by means of material organs.

Repetition is thus necessary to make a durable impression on the brain. According to this principle, it follows, that in learning a language or science, six successive months of application will be more effectual in fixing it in the mind, and making it a part of its furniture, than double or treble the time, if the lessons are interrupted by long intervals. Hence it is a great error to begin and study, and then break off to finish at a later period. The

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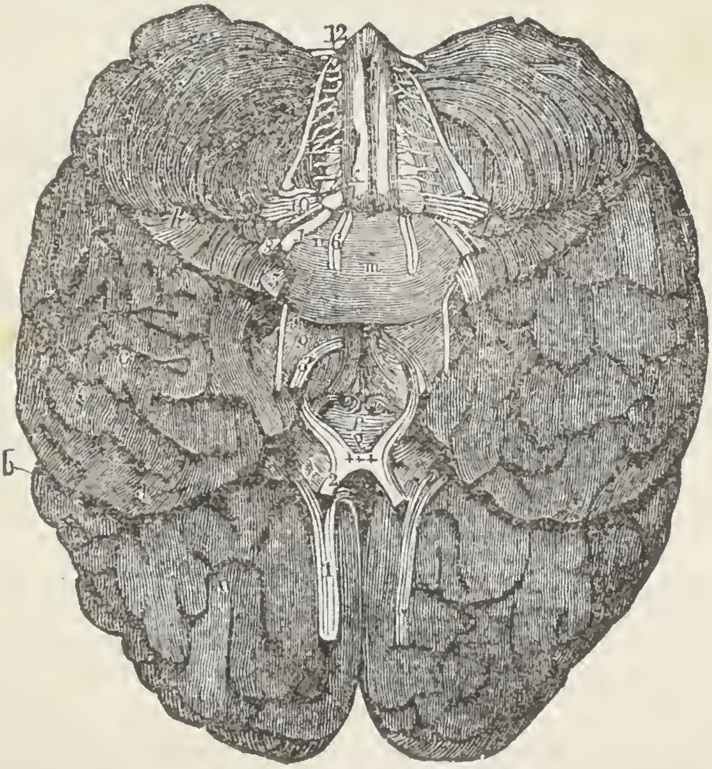
What is another characteristic of the nervous system? What is the tendency of this? What is little adverted to in mental education? Why? How is it with physical education? Why is *repetition* necessary in mental efforts? What is said of learning a language or science?

ennui is thus doubled, and the success greatly diminished. *The best way is, to begin at the proper age, and to persevere till the end is attained.* This accustoms the mind to sound exertion, and not to *fits* of attention. Hence the evil arising from long vacations, and hence the evil of beginning studies before the age at which they can be understood, as in teaching the abstract rules of grammar to children; to succeed in which implies in them a power of thinking, and an amount of general knowledge, which they do not possess.

CRANIAL NERVES.

There are *nine pairs* of cranial nerves. Taken in their order from before, backwards, they are — 1st. Olfactory. 2d. Optic. 3d. Motores oculorum. 4th. Pathetici (trochleares.) 5th. Trifacial (trigemini.) 6th. The abducentes. 7th. Facial (portio dura) auditory (portio mollis.) 8th. Glosso-pharyngeal, pneumogastric, (vagus, par. vagum,) spinal accessory. 9th. Hypo-glossal (lingual.)

Fig. 157.



How many pairs of nerves issue from the base of the brain? Give their names.

In fig. 157 the base of the brain is divided into three lobes, marked *a* for the anterior, *c* for the middle, while the convolutions of the posterior lobes may be seen on each side of the cerebellum, which is marked *f*; *b*, is the depression that divides the anterior from the middle lobe ; *d*, the convolutions forming an external covering for the whole of the cerebrum ; *e*, depression between the convolutions ; *h*, horizontal fissure or line of separation ; *i*, spinal cord ; *k*, pyramidal body, and *l*, the olivary body, two prominences situated at the head of the anterior columns of the spinal cord ; *m*, the bridge of Varolius. This bridge, of whitish substance, maintains and unites one half of the cerebellum with the other, and beneath which passes a prolongation from the cerebrum ; *o*, *n*, prolongation from the cerebellum to form the bridge ; *p*, two small rounded eminences, named. from their form, the mammillary ; *q*. an enlargement called the tuber cinerium ; 1, the olfactory nerve : *, its bulb, and **. its three roots ; 2, the optic nerve ; ***, meeting of the nerves from the opposite sides, called the decussation, or crossing of the nerve ; 3, 4, 6, nerves that go to the muscles of the eye ; 5, the trifacial nerve ; 7, the facial nerve ; 8, the auditory nerve ; 9, the glosso-pharyngeal nerve ; 10, the pneumogastric nerve ; 11, the hypo-glossal nerve ; 12, the spinal accessory nerve.

The origin of these nerves, at the base of the brain, is seen in fig. 157.

These nerves are functionally or physiologically divided into four groups, and in this order we shall examine them:

1. *Nerves of Special Sense.* — 1st, olfactory ; 2d, optic ; 7th, auditory.

2. *Motion.* — 3d, Motores oculorum ; 6th, abducentes ; 9th, hypo-glossal.

3. *Respiration.* — 4th, Patheticus ; 7th, facial ; 8th, glosso-pharyngeal. Pneumogastric ; spinal accessory.

4. *Spinal.* — 5th, Trifacial.

NERVES OF SPECIAL SENSE.

1st pair, *olfactory.* This nerve passes through the cribriform plate of the ethmoid bones, and ramifies on the membrane that covers the vomer and turbinated bones of the nose. (*See Sense of Smell.*)

2d pair, *optic.* This nerve pierces and is spread out on the back part of the orbit of the eye. (*See Sense of Vision.*)

7th pair, *auditory,* (portio mollis.) This nerve enters the petrous bone at the internal auditory foramen, and is distributed in the internal ear. (*See Sense of Hearing.*)

NERVES OF MOTION.

3d pair, *motores oculorum.* This nerve ramifies on the muscles of the eye.

6th pair, *abducentes.* This nerve is appropriated to the external straight muscle of the eye.

Into how many groups are these nerves divided, functionally and physiologically ? What are they called ? Give the names of each division. Describe the course of the olfactory nerve. The optic nerve. The auditory. Describe the third, sixth, and ninth pairs of nerves.

9th pair, *hypo-glossal* (lingual.) This is the true motor nerve of the tongue, and ramifies upon the lingual muscles. This nerve communicates with the pneumogastric, spinal accessory, first and second cervical nerves, and the sympathetic nerve.

Fig. 158.

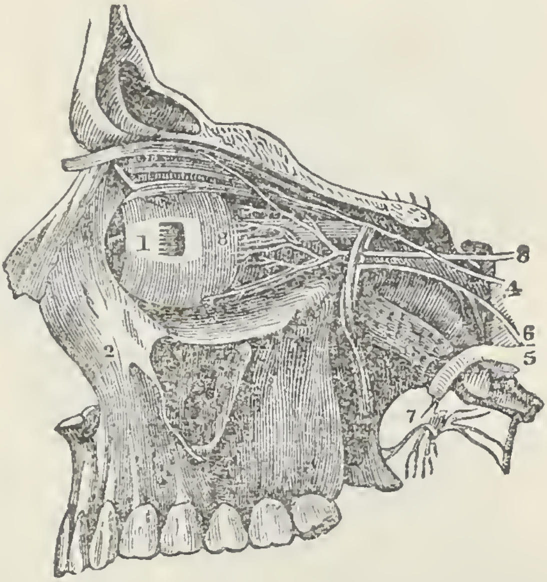


Fig. 158. A view of the third, fourth, and sixth pairs of nerves. 1, The ball of the eye and rectus externus muscle ; 2, the upper jaw ; 3, the third pair, distributed to all the muscles of the eye except the superior oblique and external rectus ; 4, the fourth pair, going to the superior oblique muscle ; 5, one of the branches of the seventh pair ; 6, the sixth pair, distributed to the external rectus : 7, the spheno-palatine ganglion and branches ; 8, ciliary nerves from the lenticular ganglion.

ANATOMY OF THE RESPIRATORY NERVES.

Sir Charles Bell groups under this head certain nerves which are associated in the movements of respiration. They all arise in the course of a distinct tract, situated between the corpus olivare and corpus restiforme, on each side of the medulla oblongata. Hence, this portion of the brain has been named the respiratory tract.

For the origin of the respiratory nerves, see Fig. 160 and its explanation.

The first of these nerves is the 4th pair, *pathetici* (trochlearis.) This is distributed upon the superior oblique or trochlearis muscle.

Explain fig. 158. What nerves did Sir Charles Bell call the respiratory? Describe their origin. What is the fourth pair of nerves called, which issue from the brain?

The second of these nerves is the 7th pair, *facial* (portio dura.) This nerve passes from the cranium at the stylo mastoid foramen, below the ear. It is distributed over the side of the face, supplying the muscles.

Fig. 159.

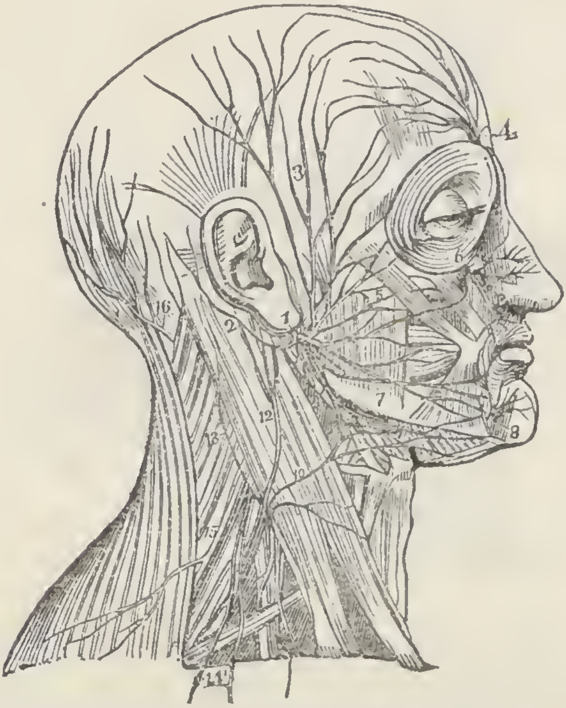


Fig. 159. The distribution of the facial nerves, and some of the branches of the cervical plexus of nerves. 1, The facial nerve, escaping from the stylo-mastoid foramen; 2, the posterior auricular branch; 3, the temporal branch; 4, the frontal nerve; 5, facial branches; 6, the infra orbitar nerve; 7, facial branches; 8, the mental nerve; 9, branches to the face and neck; 10, the superficialis colli nerve, forming a plexus, (11,) over the submaxillary gland; 12, 13, 14, 15 and 16, nerves that have their origin in the cervical portion of the spinal cord. They are distributed to the muscles and skin of the neck and back of the head. The nerves 1, 2, 3, 5, 7, and 9, are branches of the seventh pair, and are distributed over the face in a radiated direction, which constitutes the pes anserinus. The nerves 4, 6, 8, are branches of the fifth pair. The branches of the fifth, seventh and cervical nerves communicate with each other.

The third of these nerves is the 8th pair. This pair consists of three nerves; the *glosso-pharyngeal*, *pneumogastric*, and *spinal accessory*.

The glosso-pharyngeal nerve is distributed to the mucous membrane of the side and base of the tongue and fauces, and also to the mucous glands of the mouth, and to the tonsils.

The seventh pair? Where distributed? The eighth pair? Into how many branches is this pair divided? Where is the glosso-pharyngeal distributed?

Fig. 160.

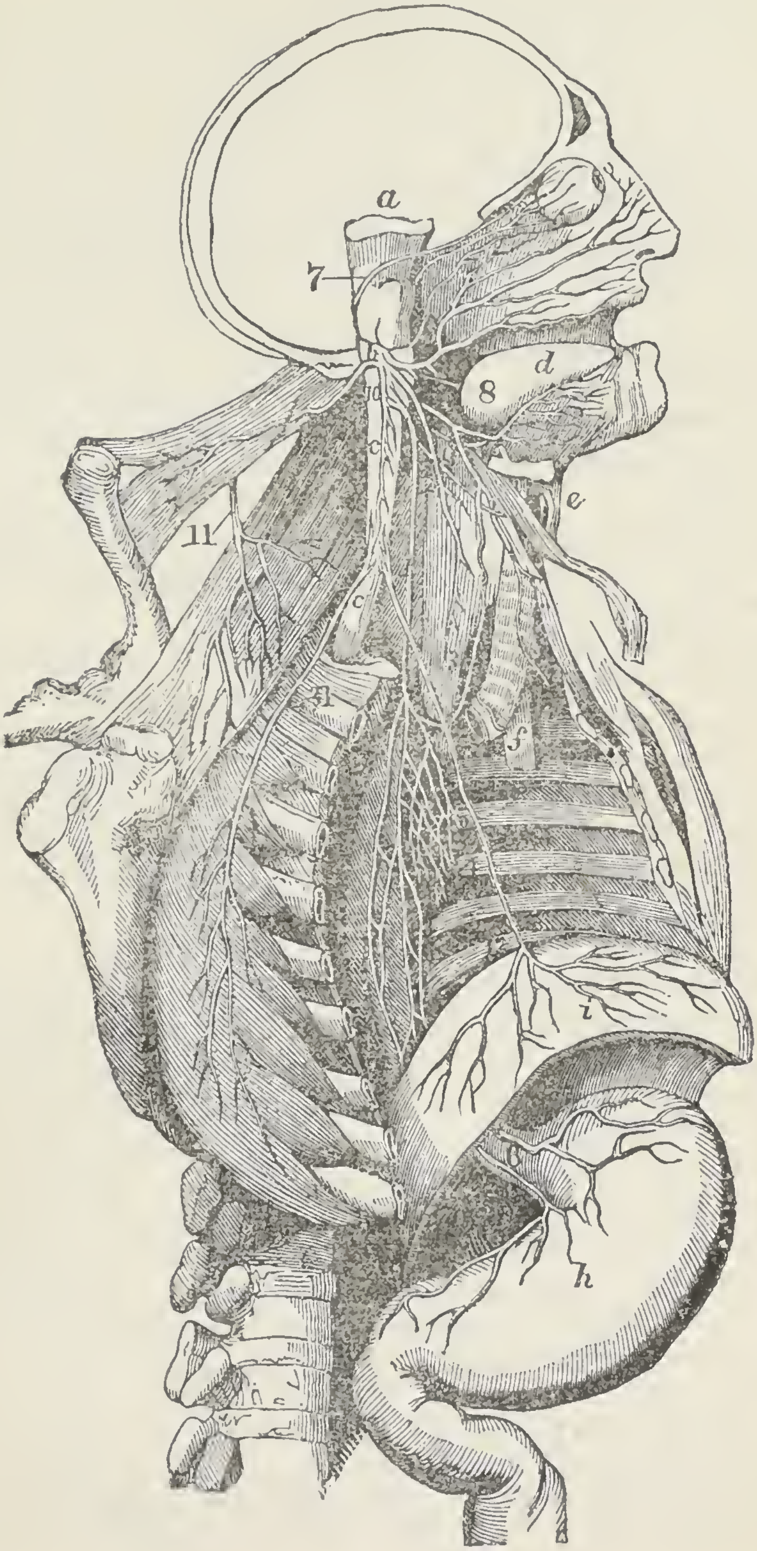


Fig. 160. *a*, Section of the brain and medulla oblongata; *b*, the lateral columns of the spinal cord; *c*, *c*, the spinal cord; *d*, the tongue; *e*, the larynx; *f*, the bronchi; 6, the œsophagus; *h*, the stomach; *i*, the diaphragm; 1, the pneumogastric nerve; 2, the superior laryngeal nerve; 3, the recurrent laryngeal nerve. These two ramify on the larynx. 4, The pulmonary plexus of the eighth nerve; 5, the cardiac plexus of the eighth nerve. These two plexuses supply the heart and lungs with nervous filaments. 7, Origin of the fourth pair of nerves, that goes to the superior oblique muscle of the eye; 8, origin of the facial nerve, that is spread out on the side of the face and nose; 9, origin of the glosso-pharyngeal nerve, that goes to the tongue and pharynx; 10, origin of the spinal accessory nerve of Willis; 11, this nerve penetrating the sterno-mastoid muscle; 12, origin of the internal respiratory or phrenic nerve, that is seen to ramify on the diaphragm; 13, origin of the external respiratory nerve, that ramifies on the pectoral and scaleni muscles. Let the pupil, from this graphic engraving, explain the distribution of the respiratory nerves.

The pneumogastric nerve (vagus) sends branches to the *larynx, pharynx, œsophagus, lungs, spleen, pancreas, liver, stomach, and intestines.* It communicates with the glosso-pharyngeal, spinal accessory, hypo-glossal, and sympathetic.

The spinal accessory nerve passes through the sterno mastoid muscle, to which it sends branches, and also to the trapezius muscle.

The phrenic nerve passes from the lateral column of the spinal cord, and is distributed to the diaphragm.

The external respiratory nerves pass with the phrenic nerve from the same tract of matter in the spinal cord. It is distributed to the intercostal muscles that lie between the ribs, and to the muscles that connect the ribs with the shoulder.

PHYSIOLOGY OF THE RESPIRATORY NERVES.

It is through the instrumentality of the *accessory, phrenic*, and *external respiratory* nerves, that the muscles employed in respiration are brought into action, without the necessity of the interference of the mind. Though to a certain extent they may be under the influence of the will, yet it is only in a secondary degree. No one can long suspend the movements of respiration; for in a short time instinctive feeling issues its irresistible mandate, which neither requires the aid of erring wisdom, nor brooks the capricious interference of the will.

The fourth, seventh, and eighth pairs of nerves, with the

The pneumogastric? With what does this nerve communicate? Where does the spinal accessory nerve pass? The phrenic nerve? Describe the external respiratory nerves. Through the agency of what nerves are the respiratory muscles brought into action? Can respiration be suspended for any considerable length of time?

spinal accessory, phrenic, and external respiratory, are not only connected with the function of respiration, but contribute to the expression of the passions and emotions of the mind.

The influence of this order of nerves in the expression of the passions, is strikingly depicted in Sir Charles Bell's Treatise on the Nervous System. 'In terror,' he remarks, 'we can readily conceive why a man stands with his eyes intently fixed on the object of his fears — the eye-brows elevated, and the eye-balls largely uncovered; or why, with hesitating and bewildered steps, his eyes are rapidly and wildly in search of something. In this way we only perceive the intense application of his mind to the objects of his apprehension, and its direct influence on the outward organs. But when we observe him further, there is a spasm in his breast; he cannot breathe freely; the chest remains elevated, and his respiration is short and rapid. There is a gasping and convulsive motion of his lips, a tremor on his hollow cheeks, a gasping and catching of his throat; his heart knocks at his ribs, while yet there is no force in the circulation; the lips and cheeks being ashy pale.

'These nerves are the instruments of expression, from the smile upon the infant's cheek, to the last agony of life. It is when the strong man is subdued by this mysterious influence of soul on body, and when the passions may be truly said to tear the heart, that we have the most afflicting picture of human frailty, and the most unequivocal proof that it is the order of functions we have been considering, that is thus affected. In the first struggle of the infant to draw breath, in the man recovering from a state of suffocation, and in the agony of passion, when the breast labors from the influence at the heart, the same system of parts is affected, the same nerves, the same muscles, and the symptoms or character have a strict resemblance.'

The facial nerve not only communicates the purposes of the will to the muscles of the face, but at the same time, it calls them into action under the influence of instinct and sympathy. On this subject a late writer re-

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What does Sir Charles Bell say of the influence of this order of nerves in the expression of the passions? Are they also the instruments of expression, either of joy or grief?

marks, 'how expressive is the face of man! How clearly it announces the thoughts and sentiments of the mind! How well depicted are the passions on his countenance! tumultuous rage, abject fear, devoted love, envy, hatred, grief, and every other emotion, in all their shades and diversities, are imprinted there in characters so clear that he that runs may read! How difficult, nay, how impossible is it to hide or falsify the expressions which indicate the internal feelings! Thus conscious guilt shrinks from detection, innocence declares its confidence, and hope anticipates with bright expectation.'

ANATOMY OF THE TRIFACIAL NERVE.

The 5th pair of nerves, sometimes called the *trigemini,* is analogous to the spinal nerves in its origin by two roots, from the anterior and posterior columns of the spinal cord, and, in the existence of a ganglion on the posterior root, called the casserion. Hence it ranges with the spinal nerves, and is considered the cranial spinal nerve.

This nerve divides into three branches, the *ophthalmic*, *superior maxillary*, and *inferior maxillary* nerve.

The *ophthalmic* branch sends a branch to the forehead, called the *frontal;* another branch to the eye, called the *lachrymal;* and a third branch to the nose, called the *nasal.*

The *superior maxillary* nerve passes through the foramen rotundum, and sends nervous twigs to the eye, to the teeth of the upper jaw, and to the muscles of the face.

The *inferior maxillary* nerve escapes from the cranium, through the foramen ovale. Emerging at the foramen ovale, the nerve divides into two trunks—external and internal.

The *external trunk*, into which may be traced the whole of the motor root, divides into four branches, which are distributed upon the masseter, temporal, buccal, and pterygoid muscles.

What name is given to the fifth pair of nerves? Why is it classed with the cranial spinal nerves? Give the names of its branches. Where do the filaments of the ophthalmic branch ramify? The superior maxillary? Describe the inferior maxillary nerve. Describe its external trunk.

The *internal trunk* divides into three branches—the *gustatory*, the *inferior dental*, and the *auricular*.

The *gustatory* nerve divides into many filaments, which are distributed to the papillæ, and mucous membrane of the tongue.

The *inferior dental* nerve runs along the canal of the inferior maxillary bone, distributing branches to the teeth.

The *auricular* nerve is distributed upon the parts about the anterior parts of the ear.

The following engraving gives a view of the distribution of the fifth pair of nerves.

Fig. 161.

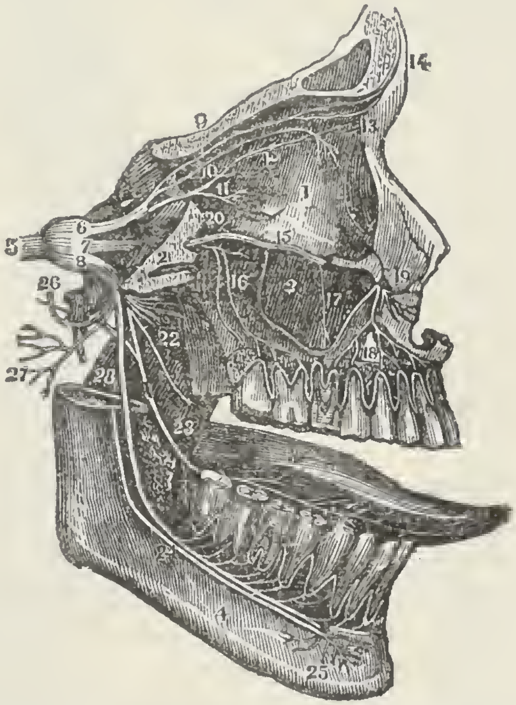


Fig. 161. 1, the orbit; 2, the antrum of the upper jaw; 3, the tongue; 4, the lower jaw; 5, the root of the fifth pair of nerves, forming the ganglion of gasser; 6, the first branch of the fifth pair, or opthalmic, 7, the second branch of the fifth pair or superior maxillary; 8, the third branch of the fifth pair, or inferior maxillary; 9, the frontal branch, dividing into external and internal frontal nerves; 10, the lachrymal branch of the fifth pair; 11, the nasal branch; 12, the internal nasal nerve; 13, the external nasal nerve; 14, the external and internal frontal nerve; 15, the infra-orbitary nerve; 16, the posterior dental branches; 17, the middle dental branch; 18, the anterior dental nerve; 19, the terminating branches of the infra-orbital nerve; 20, the malar branch; 21, the pterygoid, or recurrent nerve; 22, the five anterior branches of the third branch of the fifth pair; 23, the lingual branch of the fifth, joined by the chorda tympani; 24, the inferior dental nerve; 25, its mental branches; 26, the superficial temporal nerve; 27, the auricular branches; 28, the mylo-hyoid branch; x x, a tooth in the upper and lower jaw, divided, so as to exhibit the roots traversed by nerves from the fifth pair, which ramifies on the pulp situated in the crown.

PHYSIOLOGY OF THE TRIFACIAL NERVE.

The fifth pair of nerves is distributed to the parts of the face on which the facial or seventh pair of nerves ramifies. The former serves for sensation, the latter for motion. Thus, when the facial nerve is divided, or its functions destroyed by disease, the side affected loses all power of expression, though sensation remains unaffected. On the contrary, if we divide the fifth pair, sensation is entirely destroyed, while expression remains.

One of the branches of the trifacial nerve ramifies on the tongue and constitutes the nerve of taste. The painful sensations experienced on the face and in the teeth or jaws are induced by irritation and disease of a portion of the filaments of this nerve. The unpleasant sensation sometimes experienced when we hear the grating of a file or a saw, is produced by the connection of the chordæ tympani, a nerve that passes across the drum of the ear, with the fifth nerve.

ANATOMY OF THE SPINAL CORD.

The spinal column contains the *spinal cord*, or medulla spinalis, the roots of the spinal nerves, and the membranes of the cord, viz., the *dura mater*, *arachnoid*, and *pia mater*.

The *spinal cord* extends from the bridge of Varolius, to the second lumbar vertebra, where it terminates in a rounded point. It presents a difference of diameter in different parts of its extent, and exhibits three enlargements. The uppermost of these is the medulla oblongata; the next corresponds with the origin of the nerves distributed to the upper extremities; the third enlargement is situated near the termination of the cord, and corresponds with the attachment of the nerves which are intended for the supply of the lower extremities.

What is the function of the fifth pair of nerves? Of the seventh? What is the effect when the motor nerve is destroyed? The nerve of sensation? What nerve ramifies on the tongue? How will you account for the peculiar sensation of the teeth, when hearing the gratings of a file or saw? What does the spinal column contain? Give the extent of the spinal cord. How many enlargements has this cord? What is said of each enlargement?

Fig. 162.

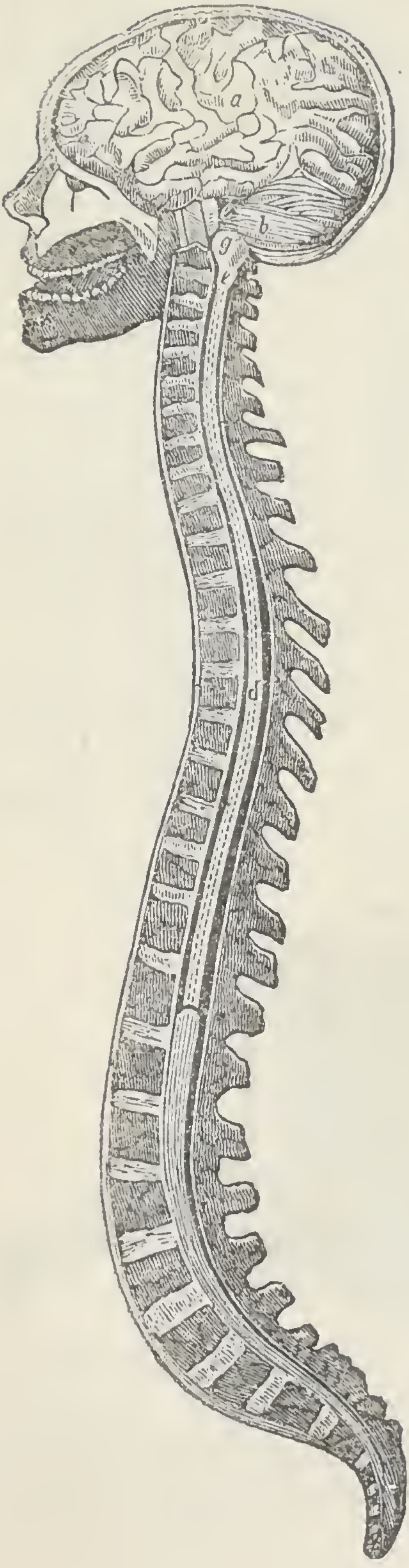


Fig. 163.

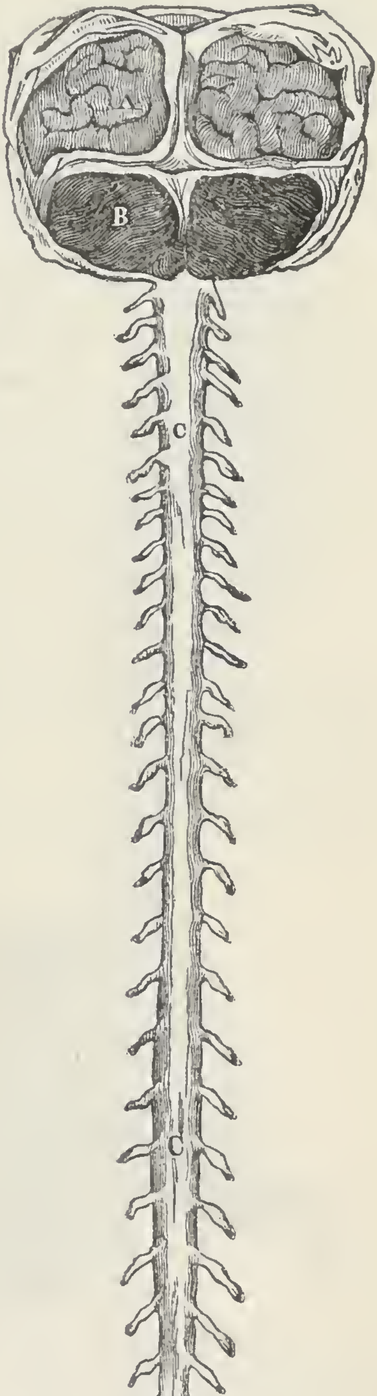


Fig. 162. *a*, The cerebrum, *b*, the cerebellum; *g*, the medulla oblongata; *e*, the pons varolii, or bridge of Varolius; *c*, *d*, the spinal cord. The brain, spinal cord, and bone of the vertebral column, are represented as divided into two halves.

Fig. 163. A, the posterior lobe of the cerebrum; B, the cerebellum. This is separated from the cerebrum by a process of the dura mater named the tentorium. *c*, *c*, The spinal cord surrounded by its sheath. Twenty-nine pairs of nerves are seen coming from it, each nerve having an enlargement named a ganglion.

An anterior and posterior fissure divides the spinal cord into two lateral cords. These are united by a thin stratum of white substance. The lateral cords are each divided by sulci, or furrows, into three columns, viz., anterior, lateral, and posterior.

The *anterior* are the motor columns, and give origin to the motor roots of the spinal nerves.

The *posterior* are the *columns of sensation*, and give origin to the sensitive roots of the spinal nerves.

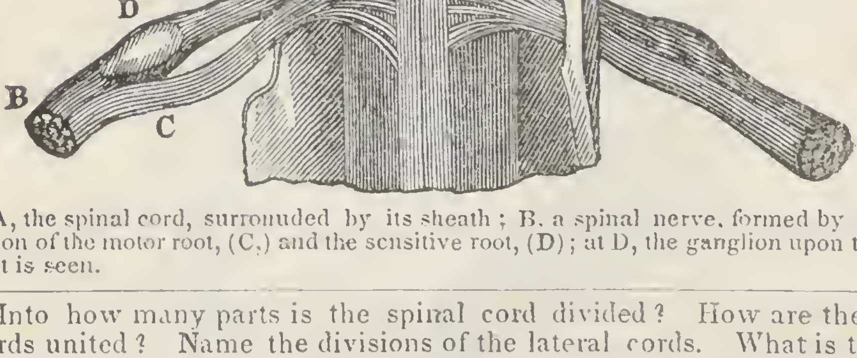
The *lateral* columns are divided in their function between motion and sensation. They contain the fasciculus described by Sir Charles Bell as the respiratory tract.

THE SPINAL NERVES.

There are thirty-one pairs of spinal nerves, each arising by two roots—an anterior, or *motive* root; and a posterior, or *sensitive* root.

The *anterior* roots arise from a narrow white line upon the anterior columns of the spinal cord.

Fig. 164.



A, the spinal cord, surrounded by its sheath; B, a spinal nerve, formed by the union of the motor root, (C,) and the sensitive root, (D); at D, the ganglion upon this root is seen.

Into how many parts is the spinal cord divided? How are these cords united? Name the divisions of the lateral cords. What is the function of the anterior column? The posterior? The lateral columns? How many pairs of nerves issue from the spinal cord? Give the origin of the anterior roots.

The *posterior* roots arise from a narrow gray band formed by the internal gray substance of the cord. They are larger, and the filaments of origin more numerous than those of the anterior roots. A *ganglion* is found upon each of the posterior roots in the foramina in the bones of the vertebræ, through which the nerve passes.

Fig. 165.

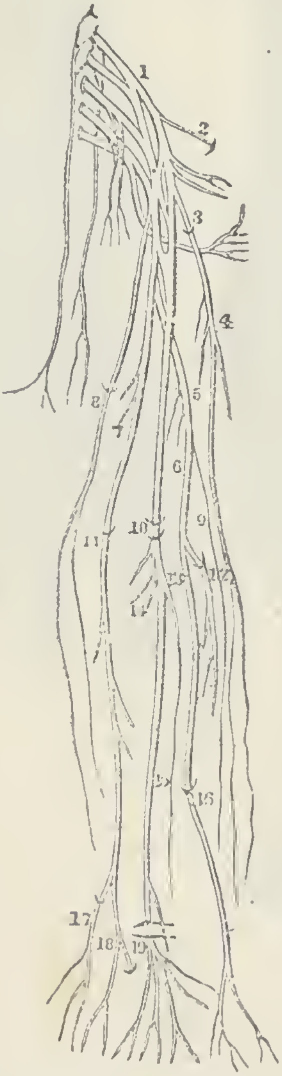


Fig. 166.

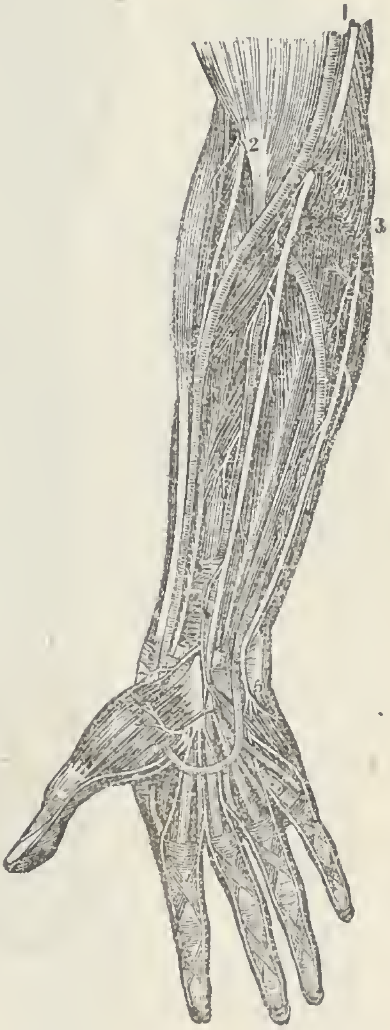


Fig. 165. *The brachial plexus of nerves with its branches and their distribution*, on the arm and forearm—1, the brachial plexus; 2, the short thoracic nerves; 3 and 4, the external cutaneous nerve; 5, 6, 16, the muscular spiral nerve; 7, and 11, the ulnar nerve; 8, the internal cutaneous nerve; 9, the spiral cutaneous nerve; 10, 13, the median nerve; 12, the posterior interroseous nerve; 14, muscular branches of the radial nerve; 15, its interosseous branch; 17, the dorsal branch of the ulnar nerve; 18, the termination of the ulnar nerve, dividing into superficial and deep seated; 19, the point where the median nerve divides into six branches, which ramify upon the hand and fingers.

Give the origin of the posterior root. In what respects do the posterior roots differ from the anterior?

Fig. 166. Nerves in front of the fore arm; 1, the median nerve; 2, the anterior branch of the muscular-spiral or radial nerve; 3, the ulnar nerve; 4, division of the median nerve in the palm to the thumb, 1st. 2nd, and radial side of the 3d finger; 5, division of the ulnar nerve to the ulnar side of the 3d and both sides of the 4th finger. The ulnar nerve passes over the point of the elbow, and its distribution explains the sensation experienced in the 4th and one side of the 3d finger, when the elbow receives a blow.

Fig. 167.

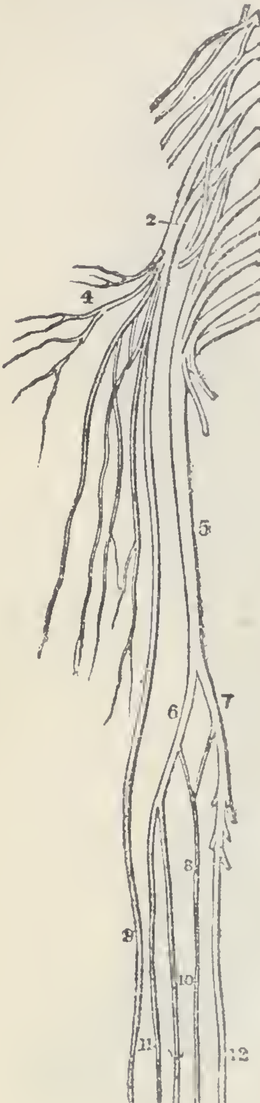


Fig. 168.

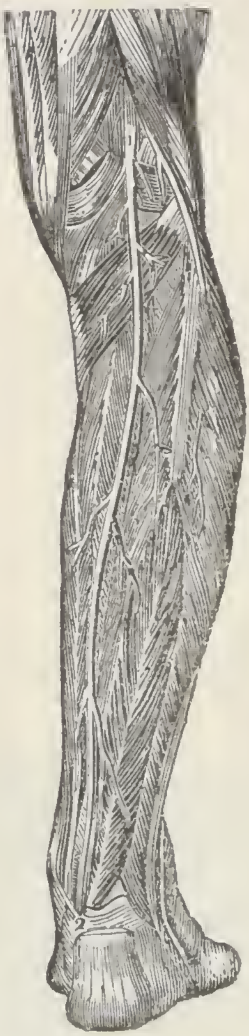


Fig. 169.

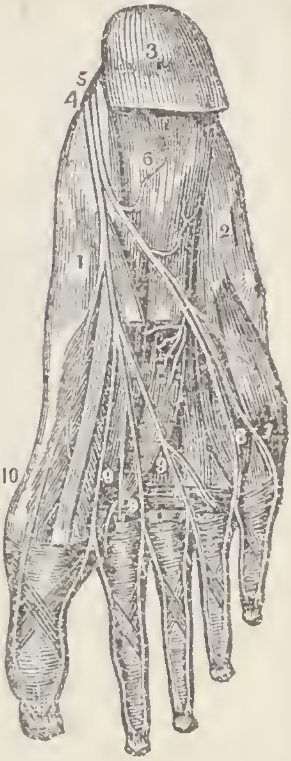
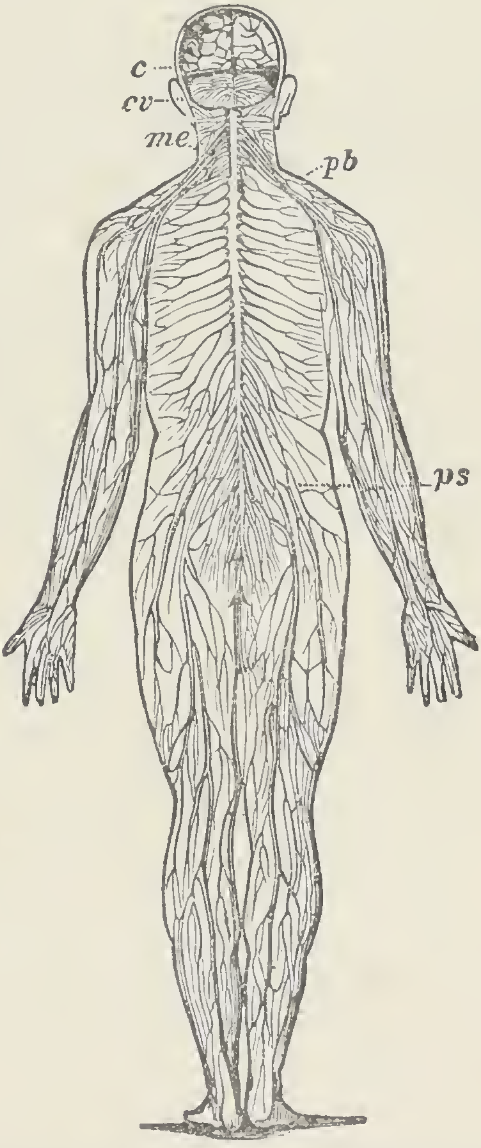


Fig. 167, a diagram showing the lumbar and sacral plexuses with the nerves of the lower extremity. 1, The five lumbar nerves, which, with a branch from the last dorsal, constitute the lumbar plexus; 2. the femoral or crural nerve; 3, the four upper sacral nerves, which with the last lumbar, form the sacral plexus; 4, the external cutaneous nerve; 5, the great ischiatic nerve; 6, the peroneal nerve; 7, the popliteal nerve ; 8, the external saphenous nerve , 9, the long or internal saphenous nerve ; 10, the short saphenous nerve ; 11, the anterior tibial nerve ; 12, the posterior tibial nerve, dividing at 13 into the two plantar nerves.

Fig. 168 ; a view of the posterior tibial nerve in the back of the leg. 1, 2, indicate its courses ; the upper part of the peroneal nerve being seen to the right.

Fig. 169 ; a view of the termination of the posterior tibial nerve in the sole of the foot. 1, The inside of the foot , 2, the outer side of the foot ; 3, the heel ; 4, the internal plantar nerve ; 5, the external plantar nerve ; 6, branch to the flexor brevis muscle ; 7, branch to the outside of the little toe ; 8, branch to the space between the fourth and fifth toes ; 9, 9, 9, digital branches to the remaining spaces ; 10, branch to the internal side of the great toe.

Fig. 170.



The Nervous System. *c*, the cerebrum ; *cv*, the cerebellum ; *me*, the spinal marrow, from which arise a great many nerves, which ramify over all parts of the body ; *pb*, the brachial plexus or reunion or assemblage of the different nerves which are distributed to the arms ; *ps*, the sciatic plexus or assemblage of nerves, forming the great sciatic nerve, which descends to the lower extremities.

After the formation of the ganglion, the two roots unite, and constitute a spinal nerve, which passes through the foramen on the sides of the spinal column.

Each nerve is surrounded by a *neurilema*, or sheath. The nerves divide and subdivide, until their minute filaments ramify on the tissues of the different organs.

The *spinal nerves* are divided into—

Cervical,	- - - - -	8 pairs,
Dorsal,	- - - - -	12 "
Lumbar,	- - - - -	5 "
Sacral,	- - - - -	6. "

The lower cervical and upper dorsal, pass into each other, and then separate to reunite. This is called the *brachial plexus.* From this plexus six nerves proceed, which ramify upon the muscles and skin of the upper extremities.

The last dorsal and the five lumbar nerves, form a plexus called the lumbar, similar to that of the cervical. From this there pass six nerves, which ramify upon the muscles and skin of the lower extremities.

The last lumbar and the four upper sacral, unite to form the sacral plexus. From this plexus, five nerves proceed, that are distributed upon the muscles and skin of the hip and lower extremities.

PHYSIOLOGY OF THE SPINAL CORD AND NERVES.

The *spinal cord*, and *spinal nerves*, possess motor and sensitive tracts and filaments. In those parts that require sensation for their safety and the performance of their functions, there is an abundant supply of sensitive nervous filaments. The muscular fibres that possess the property of shortening are supplied with motor nervous filaments, by the agency of which contractility is induced.

The nerves of sensation are mostly distributed upon the skin. Few filaments ramify upon the mucous membranes. For a description of the structure and functions of the sentient nerves, *see nerves of the skin.*

When do the two roots unite, and where do they pass? With what is each nerve surrounded? Give the divisions of the spinal nerves. What is called the brachial plexus? How many nerves pass from this plexus? How many nerves from the lumbar plexus, and where do they ramify? How is the sacral plexus formed? Where are the nerves of sensation mostly distributed?

The functions of the muscular nerves are different from the sentient nerves. The former are provided for the purpose of motion, and not of feeling. Hence, muscles may be cut and the pain will be slight compared with the cutting of the skin. Weariness is a sensation recognized by one set of muscular nerves. So uniformly is a separate instrument provided for every additional function, that there is strong reason to regard the muscular nerves, although running in one sheath, as in reality double, and performing distinct functions. Sir Charles Bell, in his work on the Nervous System, endeavors to show, that one set of nervous fibres conveys the mandate from the brain to the muscle, and excites the contraction, and that another set conveys from the muscle to the brain, a peculiar sense of the state or degree of contraction of the muscle, by which we are enabled to judge of the amount of stimulus necessary to accomplish the end desired. This is obviously an indispensable piece of information to the mind in regulating the movements of the body. 'The muscles have two nerves,' says Sir Charles, 'which fact has not hitherto been noticed, because they are commonly bound up together. But whenever the nerves, as about the head, go in a separate course, we find that there are a sensitive nerve and a motor nerve distributed to the muscular fibre, and we have reason to conclude, that those branches of the spinal nerves which go to the muscles, consist of a motor and a sensitive filament.

'It has been supposed hitherto, that the office of a muscular nerve is only to carry out the mandate of the will, and to excite the muscle to action. But this betrays a very inaccurate knowledge of the action of the muscular system; for, before the muscular system can be controlled under the influence of the will, there must be a consciousness or knowledge of the condition of the muscle.

'When we admit that the various conditions of the muscle must be estimated or perceived in order to be under the due control of the will, the natural question

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Why is there less pain in a muscle, when it is cut, than in the skin? What reason have we to suppose that the muscular or motor nerves are double, though enclosed in one sheath? What is the doctrine of Sir Charles Bell on the subject? How does he divide the muscular nerves, and define their separate functions? What error does he contravene as to the office of the muscular nerve.

arises—Is that nerve which carries out the mandate of the will, capable of conveying, at the same moment, an impression retrograde to the course of that influence which is going from the brain to the muscle? If we had no facts in anatomy to proceed upon, still reason would declare to us that the same filament of a nerve could not convey a motion, of whatever nature that motion may be, whether vibration or motion of spirits, in opposite directions at the same time.

'I find that to the full operation of the muscular power, two distinct filaments of nerves are necessary, and that a circle is established between the sensorium and the muscle. One filament or single nerve carries the influence of the will towards the muscle, which nerve has no power to convey an impression backward to the brain. Another nerve connects the muscle with the brain, and acting as a sentient nerve, conveys the impression of the condition of the muscle to the mind, but has no operation in a direction outward from the brain toward the muscle, and does not therefore excite the muscle, however irritated.'

'This consciousness of the state of the muscles, or muscular sense, as it may be truly called, is of great importance, both to man and animals, as it is necessary, by information thence derived, that every subsequent exertion be directed and apportioned in intensity to the effort required to be made. If we had no such sense, the delicate and well-directed touches of the engraver, painter, and sculptor, or of the ingenious mechanic, would be at the mercy of hazard; and a single disproportioned movement might ruin the successful labor of months. Without this sense, man could not deliberately proportion the muscular efforts to his real wants. Even in walking, his gait would be unsteady and insecure, because there would be no harmony between effort and resistance.

'In chewing our food, in turning the eye towards an object looked at, in raising the hand to the mouth, and in fact, in every variety of muscular movement which we per-

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What are Sir Charles' reasons? What are his views concerning the functions of two distinct filaments? What is the use and importance of what is called muscular sense? What would be the several disadvantages to man from a want of this sense? How are we guided by this sense on ordinary occasions?

form, we are guided by the muscular sense in proportioning the effort to the resistance to be overcome. When this harmony is destroyed by disease, the extent of the service rendered us becomes more apparent. The shake of the hand which we see in drunkards, and their consequent incapability of carrying the morsel directly to the mouth, are examples of what would be of daily occurrence, unless we we were directed and assisted by a muscular sense.'

The proper performance of the functions of the spinal nerves, requires an observance of the conditions suggested in the Physiology of the Brain and Muscular System.

SYMPATHETIC SYSTEM OF NERVES.

The SYMPATHETIC SYSTEM consists of a series of *ganglia,* extending each side of the vertebral column, from the head to the coccyx. It communicates with all the other nerves in the body, and distributes branches to all the internal organs and viscera. With the exception of the neck there is a ganglion for each intervertebral space, both of the true vertebræ and sacrum. These ganglia are composed of a mixture of cineritious and medullary matter, and are supposed to be centres of peculiar nervous power.

Fig. 171 is a beautiful engraving of the sympathetic ganglia, and their connection with other nerves. It is from the grand engraving of Manec, reduced in size.

They are called *ganglionic nerves,* from the constant disposition they evince to form small knots or ganglia.

Each ganglion may be considered as a distinct centre, giving off branches in four directions, viz: the *superior,* or *ascending,* to communicate with the ganglion above; the *inferior,* or *descending,* to communicate with the ganglion below; the *external,* to communicate with the spinal nerves; and the *internal,* to communicate with the sympathetic filaments, to be distributed to the viscera.

Of what does the sympathetic system of nerves consist? How distributed? What exception? Of what are they composed? What is the design of Fig. 171? Why are they called *ganglia?* How may each ganglia be considered? Where does the superior or ascending branch communicate? The inferior? The external? The internal?

Fig. 171.

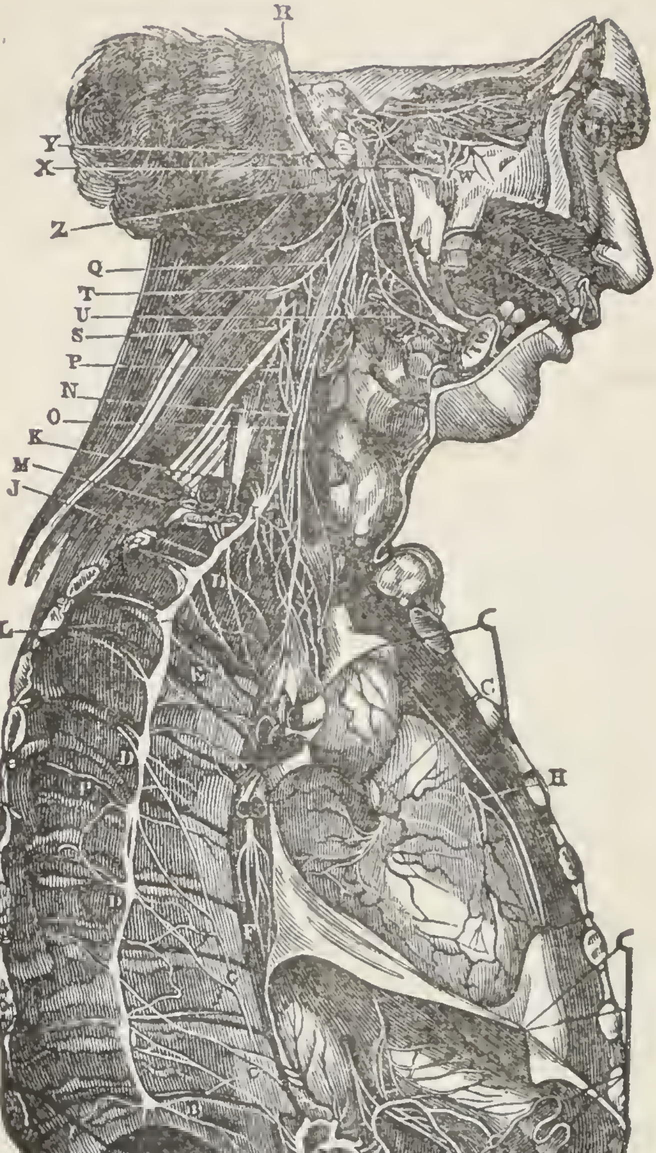

Fig. 171. A, A, A, Semilunar ganglion and solar plexus, situated below the diaphragm and behind the stomach; B, small splanchnic nerve, formed by filaments from the tenth, eleventh, and twelfth dorsal ganglia. It pierces the diaphragm and descends to join the renal plexus; C, the great splanchnic nerve. It arises from the sixth dorsal ganglion, and receives filaments from the seventh, eighth, ninth, and tenth dorsal ganglia. It pierces the diaphragm, and terminates in the semilunar ganglion; D, D, D, thoracic ganglia, ten or eleven in number; E, E, external and internal branches of the thoracic ganglia; G, the right coronary plexus, situated upon the heart; H, the left coronary plexus; I, inferior cervical ganglion; J, inferior twigs from this ganglion; K, its external threads, very slender; L, internal twigs, very minute; M, anterior thread; N, the middle cervical ganglion; O, its interior twigs; P, external twigs; Q, the superior cervical ganglion; R, its superior branches; S, inferior branches; T, external branch; U, submaxillary ganglion; V, the vidian nerve; W, its naso palatine branch; X, the spheno palatine ganglion; Z, the auditory nerve, and membrane of the tympanum, containing within its cavity four small bones of the ear; 1, the renal plexus of nerves that surrounds the kidneys; 2, the lumbar ganglion; 3, their internal branches; 4, their external branches; 5, the aortic plexus of nerves that lies upon the aorta.

Fig. 172.

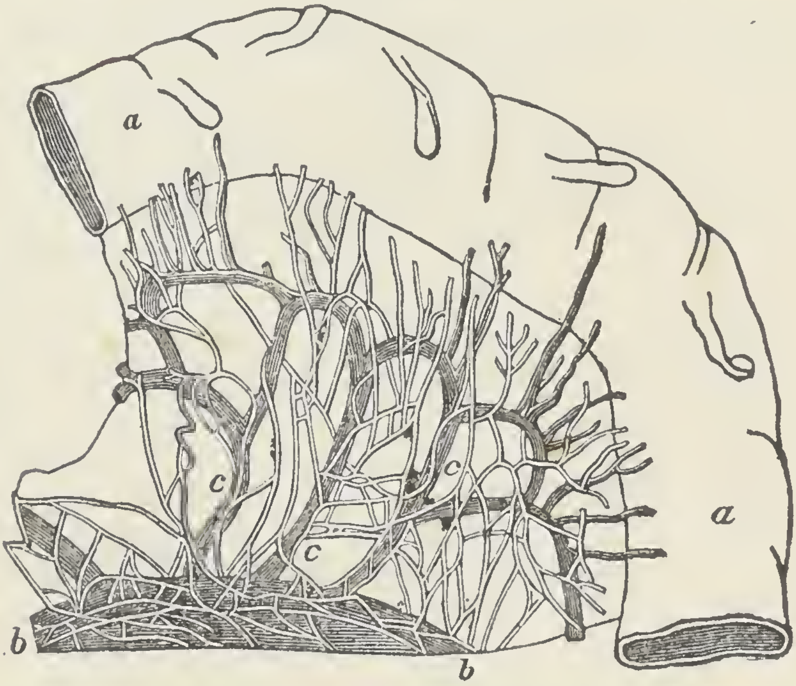

Fig. 172. *a*, *a*, A portion of intestine; *b*, *b*, part of the aorta or great artery; *c*, *c*, *c*, nerves of the intestine, following the course of the branches of the artery.

The branches of distribution accompany the arteries which supply the different organs, and form communications around them, which are called *plexuses*, and take the name of the artery with which they are associated. Thus we have the mesenteric plexus, hepatic plexus, splenic plexus, &c. All the *internal organs* of the head, neck, and trunk, are supplied with branches from the sympa-

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What is a plexus of nerves? From what do they derive their names? Why is the sympathetic considered the nerve of organic life?

thetic, and some of them exclusively; hence, it is considered a nerve of *organic life.*

There is good reason to believe, that the peculiar vitality of every organ in the body, directly depends on the sympathetic nerves. Some physiologists believe that they preside over the involuntary functions—as absorption, secretion, nutrition, &c. Others suppose the office of the ganglions is to render organs which are supplied with nerves from them, independent of the *will.* Every part of the body must, to a certain extent, be under their influence, as filaments from this system of nerves accompany the blood-vessels throughout their course.

What is the opinion of some physiologists as to the functions of these nerves? The opinion of others?

CHAPTER XI.

THE FIVE SENSES.

SENSATION is the perception of external objects by means of the senses. There are five senses; viz., *touch*, *taste*, *smell*, *hearing*, and *vision*.

SENSE OF TOUCH.

TOUCH is the sense which reveals to us the contact of foreign bodies with our organs, and informs us of the nature of their surfaces, whether rough or smooth, their movements, the degree of their consistence, their temperature, and, to a certain extent, their form, volume, and weight.

In man, the hand is the special organ of touch, and its structure is admirably well adapted to the exercise of this sense. The fineness of the skin, its great sensibility, the species of cushion, formed by the subcutaneous fat at the extremities of the fingers, the length and flexibility of these organs, and the capability of opposing the thumb to the other fingers, like a pair of forceps, are so many conditions essentially favorable to the delicacy of this sense, and enable us to appreciate with exactitude the qualities of the bodies we may feel.

'Physiologists make a distinction between *tact* and *touch*. Tact, with some few exceptions, is generally diffused through all the organs, and more particularly over the skin. This exists in all animals, while touch exists chiefly in the fingers of man, in the antennæ of insects, and in the noses of certain quadrupeds.

'In the exercise of these functions, *tact* is considered

Define sensation. How many senses have we? Define *touch*. What is the organ of touch in man? What are the circumstances which render the hand so admirably adapted to its purpose? What is the difference between touch and tact? In the exercise of these functions, which is active, and which passive?

passive, as when any part of the system comes into contact with another body, a sensation of its presence is given, without the exercise of volition. On the contrary, *touch* is active, and is exercised voluntarily, for the purpose of conveying to the mind a knowledge of the qualities or properties of the surfaces of bodies; as when we feel a piece of cloth to ascertain its qualities, or a polished surface to prove its smoothness.

The nerves in which this sense is situated proceed from the spinal cord. A full description of the structure and functions of these nerves, is given on page 251.

ANATOMY OF THE SENSE OF TASTE.

The chief organ of taste is the upper surface of the tongue; though the lips, the palate, the internal surface of the cheeks, and the upper part of the œsophagus, participate in this function.

Fig. 173.

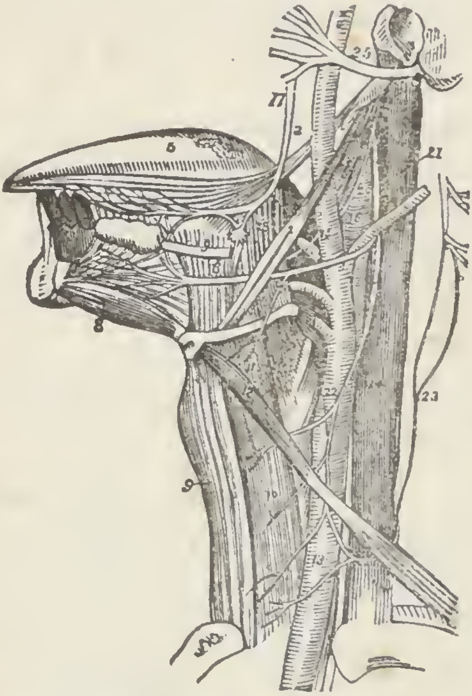

Fig. 173, The anatomy of the side of the neck, showing the nerves of the tongue; 1, a fragment of the temporal bone, containing the meatus auditorius externus, mastoid, and styloid process; 2, the stylo-hyoid muscle; 3, the stylo-glossus; 4, the stylo-pharyngeus; 5, the tongue; 6, the hyo-glossus muscle; its two portions; 7, the genio-hyo-glossus muscle; 8, the genio-hyoideus; they both arise from the

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What is the chief organ of *taste*? What other parts participate in the function?

inner surface of the symphysis of the lower jaw; 9, the sterno-hyoid muscle; 10, the sterno-thyroid; 11, the thyro-hyoid, upon which the hyoid branch of the lingual nerve is seen ramifying; 12, the omo-hyoid crossing the common carotid artery, (13,) and internal jugular vein, (14;) 15, the external carotid, giving off its branches; 16; the internal carotid; 17, the gustatory nerve, giving off a branch to the submaxillary ganglion, (18,) and communicating a little further on with the hypoglossal nerve; 19, the submaxillary, or Wharton's duct, passing forwards to the sublingual gland; 20, the glosso-pharyngeal nerve; 21, the hypoglossal nerve, curving around the occipital artery; 22, the descendans noni nerve forming a loop with (23,) the communicans noni, which is seen to be arising by filaments from the upper cervical nerves; 24, the pneumogastric nerve, emerging from between the internal jugular vein and common carotid artery, and entering the chest; 25, the facial nerve, emerging from the stylo-mastoid foramen, and crossing the external carotid artery.

The tongue is chiefly composed of muscular fibres, which run in almost every direction. It possesses great versatility of motion, and can be moulded into a great variety of shapes. In articulation, mastication, and deglutition, the tongue is an auxiliary to other organs.

This organ is abundantly supplied with blood vessels. It receives nervous filaments from the fifth, eighth, and ninth pairs of nerves. The *fifth*, called the gustatory, is the nerve of *taste* and *sensibility;* the *ninth*, called the hypoglossal, of *voluntary* motion. By means of the *eighth*, called the glosso-pharyngeal, the tongue is brought into association with the throat, œsophagus, and larynx.

'The surface of the tongue is thickly studded with fine papillæ, or *villi*, which give the organ a velvety appearance. These villi are of three varieties. The first is located near the root of the tongue. They belong to the class of mucous follicles. They are larger than the others, and are called *lenticular*, from being shaped like a lens. These, together with the tonsils, sometimes called the almonds of the ears, secrete mucus, to lubricate the food in the act of deglutition.

'The instruments of taste are the other two sets of papillæ. One set consists of small oval-shaped bodies, which are scattered over the whole surface of the tongue. They give it a rough, shaggy appearance, and are named the *conical filiform* papillæ.

'The other set of papillæ is named the *fungiform*. They are larger than the former, and consist of small rounded heads, supported on short stalks, something in the shape of mushrooms, from which they derive their name. In

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Describe the structure of the tongue. From what source does the tongue derive its nerves? What is the appearance of the surface of the tongue? What is the office of the mucous papillæ? Of the conical and fungiform papillæ?

these sensitive papillæ, the gustatory branch of the fifth pair of nerves ramifies.'

PHYSIOLOGY OF THE SENSE OF TASTE.

Taste is a sense which makes us acquainted with the savor of substances. When fluids are taken into the mouth, the papillæ dilate and erect themselves, and the sense of taste is conveyed to the brain through filaments of the gustatory nerve.

If dry, solid food be taken, the tongue carries it to the back side of the mouth, where it receives secretions from the salivary glands; the saliva becoming impregnated with its flavor, flows over the sides of the tongue, and gives to the papillæ a perception of the savory juice; this sensation is then communicated to the brain.

It is supposed that the salts which enter into the composition of the saliva, are very efficient agents in reducing substances to a proper state for making impressions on the nerves of taste. In this way we can account for the fact that *metals* impart a peculiar taste, although they are insoluble in water.

The primary use of taste is to guide animals in the selection of their food, and warn them against the introduction of noxious articles into the stomach. In all the inferior animals, we see that the original design of taste is still answered. But in man, this sense has been so abused and perverted, by the introduction of stimulants, and the endless admixture of different articles of food, that the simple action of this part seems to have been superseded almost entirely by acquired taste.

SENSE OF SMELL.

This sense is located in the air-passages of the nose. To understand the philosophy of smell, the structure of the nose and nasal fossæ, with the distribution of the olfactory nerves, must be first examined.

What nerve ramifies in the fungiform papillæ? What is taste? What is the process of taste? What is the primary use of taste? In what animals is this design still answered? How is it with man? Where is the sense of smell located? What is necessary before the philosophy of smell can be understood?

ANATOMY OF THE ORGANS OF SMELL.

The nose is composed, of 1. The *skin.* 2. The *muscles.* 3. The *bones.* 4. The *fibro-cartilages.* 5. *Mucous membrane.* 6. The *blood-vessels and nerves.* The muscles and skin have been described in Chaps. II. and IV.

The BONES of the nose are the nasal, and the nasal processes of the superior maxillary.

The FIBRO-CARTILAGES give form and stability to the frame work of the nose, providing at the same time, by their elasticity, against injuries. They are five in number.

The MUCOUS MEMBRANE, lining the interior of the nose, is continuous with the skin externally, and with the pituitary membrane of the nasal fossæ within. Around the entrance of the nostrils it is provided with numerous hairs.

The ARTERIES are branches of the carotid.

Fig. 174.

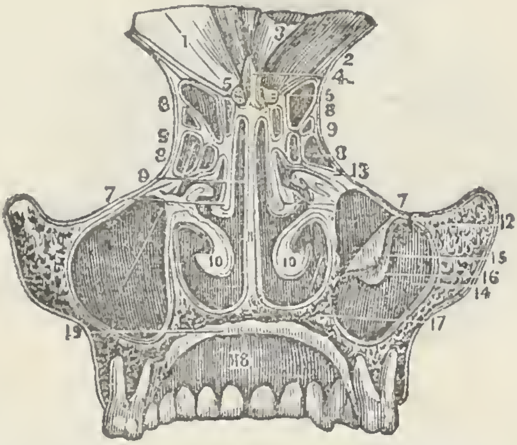

Fig. 174. A vertical section of the middle part of the nasal fossæ, giving a posterior view of the arrangement of the ethmoidal cells. 1, The anterior fossæ of the cranium , 2, the same covered by the dura mater ; 3, the dura mater turned up ; 4, the crista galli of the ethmoid bone ; 5, its cribriform plate ; 6, its nasal lamella ; 7, the middle spongy bones ; 8, the ethmoidal cells ; 9, the os planum ; 10, the inferior spongy bone ; 11, the vomer ; 12, the superior maxillary bone ; 13, its union with the ethmoid ; 14, the anterior parietes of the antrum of the upper jaw, covered by its membrane ; 15, its fibrous layer ; 16, its mucous surface ; 17, the palatine process of the superior maxillary bone ; 18, the roof of the mouth covered by mucous membrane ; 19, a section of this membrane. A bristle is seen in the orifice of the antrum of the upper jaw.

What *bones* form the frame-work of the nose? What is the use of the *cartilages*? What relation has the *mucous membrane* with other membranes of the nose? What *arteries* supply this organ?

The NERVES are from the fifth and seventh pairs, under the presidency of which the nasal muscles act.

The *nasal fossæ* are two irregular, compressed cavities, extending from the nose to the pharynx. These cavities are bounded superiorly by the sphenoid and ethmoid bones; inferiorly by the hard palate. In the middle line they are separated from each other by a bony and fibro-cartilaginous septum; upon the outer wall of each fossa, in the dried skull, are three projecting processes, termed spongy bones. In the fresh fossa these are covered by a mucous membrane. The space that intervenes between the superior and middle spongy bone is termed the *superior meatus;* the space between the middle and inferior bone is the *middle meatus*, and that between the inferior bone and floor of the fossa, is the *inferior meatus.*

Fig. 175.

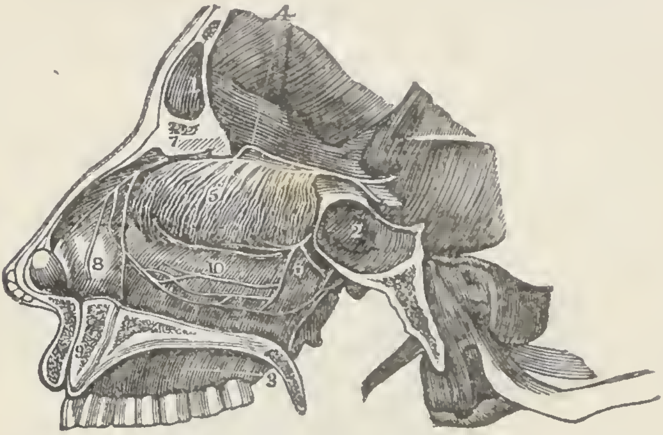

Fig. 175. A view of the first pair or olfactory nerves, with the nasal branches of the fifth pairs. 1, The frontal sinus; 2, the sphenoid sinus; 3, the hard palate; 4, the bulb of the olfactory; 5, branches of the olfactory nerve on the superior and middle turbinated bones; 6, the spheno-palatine nerve from the second branch of the fifth pair; 7, the internal nasal nerve from the first branch of the fifth pair; 8, branches of the nerve (7,) to the schneiderian membrane; 9, the ganglion of Cloquet in the foramen incisivum; 10, the anastomosis of the branches of the fifth pair on the inferior turbinated bone.

The *meatuses* are passages that extend from before backwards. Into these are several openings. They are lined with a mucous membrane, named the *pituitary*, or *Schneiderian*, from Schneider, who first showed that the

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What nerves? Describe the *nasal fossæ*? What is found on the outer wall of each fossa, in the dried skull? In the fresh skull? What are meatuses? Why was the lining membrane of these passages called the Schneiderian?

secretion proceeded from the mucous membrane, and not from the brain.

Upon the mucous membranes of the meatuses, the olfactory nerve ramifies, and also a branch of the fifth pair of nerves. The distribution of the filaments of these nerves, will be understood by examining fig. 175, on the opposite page.

During the act of inspiration, the air rushes through the meatuses. The odorant particles contained in the atmosphere are brought in contact with the fine filaments of the first and fifth pairs of nerves. The impression made upon these nerves is transmitted to the brain.

Acuteness of smell requires that the brain and nerves be in a state of health, and that the mucous membrane lining the nasal fossæ, be thin and moistened with mucus. *Snuff* and other irritants, render the sense of smell obtuse, by diminishing the sensitiveness of the nerves, and by thickening and otherwise altering the structure of the mucous membrane.

The sense of smell, like that of taste and touch, may be improved by education. It likewise varies in different persons. In some animals, as the grey-hound, this sense is remarkably acute. He not only tracks the hare, or the fox, with unerring certainty, long after their footsteps have been imprinted, but he will even trace the progress of his master through thickly crowded streets, distinguishing his footsteps from those of a thousand others, and amidst the odorous particles emanating from a thousand sources.

SENSE OF VISION.

The visual apparatus consists of the second pair, or *optic nerves, the eye balls and their appendages.*

The OPTIC NERVE arises by two roots, one from the *thalami optici*, the other from the *corpora quadrigemina.* The two nerves approach each other, as they proceed forward, and a portion of the fibres of each, cross to the nerve of the opposite side. They then diverge and enter the

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Where does the olfactory nerve ramify? How does the mind become sensible of odoriferous particles? On what does the acuteness of smell depend? Why does *snuff* render the sense of smell obtuse? Can the sense of smell be improved by education? What is said of the acuteness of smell in the grey-hound? Of what does the visual apparatus consist? Describe the course of the *optic nerve.*

globe of the right eye, through the posterior part of the sclerotic and choroid coats, and then expand, and form a soft, whitish membrane, called *retina*.

Fig. 176.

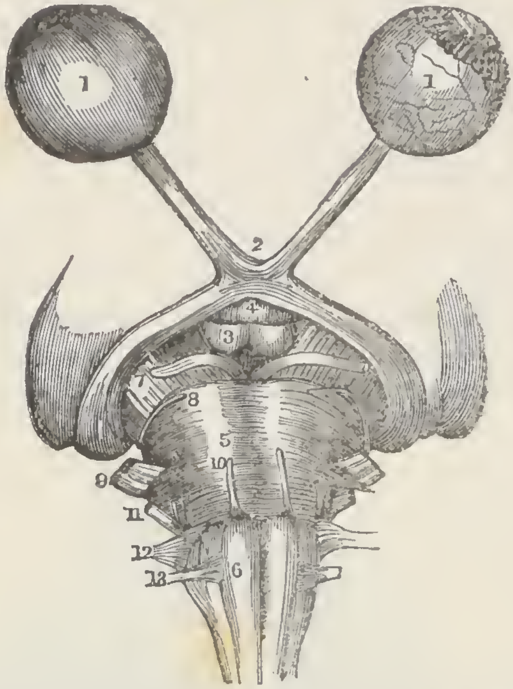

Fig. 176. A view of the second pair or optic nerves, with origin of seven other pairs. 1, 1, The globe of the eye; the one on the left hand is perfect, but that on the right has the sclerotic coats removed to show the retina. 2, The crossing of the optic nerves; the corpora albicantia; 4, the infundibulum: 5, the pons varolii; 6, the medulla oblongata; 7, the third pair of nerves: 8, the fourth pair; 9, the fifth pair; 10, the sixth pair; 11, the seventh pair; 12, the eighth pair; 13, the ninth pair.

The form of the eye-ball is that of a sphere, of about one inch in diameter. It has the segment of a smaller sphere ingrafted upon its anterior surface, which increases its antero-posterior diameter. The axes of the eye-balls are parallel to each other, but do not correspond to the axes of the orbits, which are directed outward. The optic nerves follow the direction of the orbits, and therefore enter the eye-balls at their nasal side.

The globe of the eye is composed of *tunics*, or coats, and refracting media, named *humors*. The tunics are three in number; 1. the *sclerotic* and *cornea;* 2. the

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What does fig. 176 exhibit? What is the form of the eye-ball? How are the axes of the eye-balls situated? Mention the different parts of which the globe of the eye is composed.

choroid, *iris*, and *ciliary processes*; 3. the *retina* and *zonula ciliaris*.

COATS.—The SCLEROTIC coat is a dense, fibrous membrane, and invests about four-fifths of the globe of the eye. This gives the form to the eye-ball. Its anterior surface is covered by a thin, tendinous layer, derived from the expansion of the tendons of the four recti muscles. It is named the *tunica albuginea*. This tunic is covered, for a part of its extent, by the mucous membrane of the front of the eye, the conjunctiva; and, by reason of the brilliancy of its whiteness, gives occasion to the common expression, 'the white of the eye.' Anteriorly, the sclerotic coat presents a *bevelled edge*, which receives the cornea in the same way that a watch-glass is received by the groove in its case.

The CORNEA is the transparent, projecting layer that forms the anterior fifth of the globe of the eye. In its form it is circular, convex-concavo, and resembles a watch-glass. It is received by its edge, which is sharp and thin, within the bevelled border of the sclerotic, to which it is firmly attached. The cornea is composed of four layers.

The CHOROID is a vascular membrane, of a rich chocolate brown color upon its external surface, and of a deep black within. It is connected to the sclerotic externally by an extremely fine cellular tissue, and by the passage of nerves and vessels. Internally it is in contact with the retina.

The choroid membrane is composed of three layers; 1. An *external coat*, which consists principally of veins, arranged in a peculiar manner. 2. The *middle coat* is formed principally by ramification of minute arteries. It secretes upon its surface the pigmentum nigrum. It is reflected inwards at its junction with the ciliary ligament, so as to form the ciliary processes. 3. The *internal layer* is a delicate membrane, named the *pigmentum nigrum*.

The CILIARY LIGAMENT, or circle, is the bond of union

Describe the *sclerotic* coat. Why is it sometimes called the 'white of the eye?' Describe the *cornea*. Describe the *choroid* coat. How is it connected with the sclerotic coat? Of how many layers is the choroid membrane composed? Of what does the first layer consist? The second? The third? What is the bond of union between the external and middle coat of the eye?

between the external and middle coats of the eye, and serves to connect the cornea and sclerotic at their junction with the iris and external layer of the choroid.

The IRIS is so named from its variety of color in different persons. It forms a septum between the anterior and posterior chambers of the eye, and is pierced by a circular opening, which is called the *pupil.*

It is composed of two layers. 1. The *anterior* or *muscular*, which consists of radiating fibres; these converge from the circumference towards the centre. Through the action of these radiating fibres, the pupil is dilated. 2. The *circular* fibres, which surround the pupil like a sphincter, and by their action produce contraction of its area. The posterior layer is of a deep purple tint, and is called *uvea*, from its resemblance in color to a ripe grape.

The CILIARY PROCESSES consist of a number of triangular folds, formed apparently by the plaiting of the internal layer of the choroid coat. They are about sixty in number. Their periphery is connected with the ciliary ligament and is continuous with the internal of the choroid. The central border is free, and rests against the circumference of the crystalline lens. These processes are covered by a layer of the pigmentum nigrum.

The third tunic of the eye is the RETINA, which is prolonged forward to the lens, by the zonula ciliaris. The retina is composed of three layers; the *external; middle,* or *nervous;* and *internal,* or *vascular.*

The *external membrane* is extremely thin, and is seen as a flocculent film, when the eye is suspended in water. It is called Jacob's membrane.

The *nervous membrane* is the expansion of the optic nerve, and forms a thin, semi-transparent, bluish-white layer.

The *vascular membrane* consists of the ramification of a minute artery, and its accompanying vein. This vascular layer forms distinct sheaths for the nervous papillæ, which constitute the inner surface of the retina.

What is the *iris*, and why so called? What membrane separates the anterior and posterior chambers of the eye? Of how many layers of fibres is the iris composed? What is the function of the radiating fibres? Of the circular? What is the color of the posterior layer of the iris? How are the *ciliary processes* formed? Of how many layers is the *retina* composed? What is the appearance of the external layer of the retina? Describe the nervous membrane. The vascular.

Fig. 177.

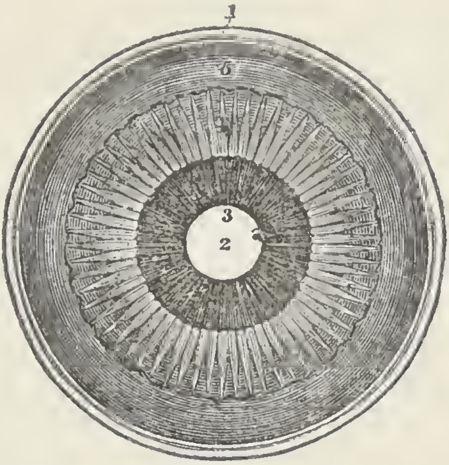

Fig. 177 is the anterior segment of a transverse section of the globe of the eye, seen from within. 1, Divided edge of the three coats—sclerotic, choroid, and retina; 2, the pupil; 3, the iris; the surface presented to view in this section being the uvea; 4, the ciliary processes; 5, the scalloped anterior border of the retina.

The *zonula ciliaris* is a thin vascular layer, which connects the anterior margin of the retina with the anterior surface of the crystalline lens, near to its circumference.

The humors are three in number; the *aqueous, crystalline* and *vitreous*.

HUMORS.—The AQUEOUS humor is situated in the anterior and posterior chambers of the eye. It is an albuminous fluid, having an akaline reaction. Its specific gravity is a very little greater than distilled water.

The *anterior chamber* is the space intervening between the cornea in front, and the iris and pupil behind.

The *posterior chamber* is the narrow space, less than half a line in depth, bounded by the posterior surface of the iris and pupil in front, and by the ciliary processes and lens behind.

The two chambers are lined by a thin layer, the secreting membrane of the aqueous humor.

The CRYSTALLINE HUMOR, or *lens*, is situated immediately behind the pupil. It is surrounded by the ciliary processes. It is more convex on the posterior than on the anterior surface; and in different portions of the sur-

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What is the zonula ciliaris? Where is the *aqueous* humor situated? What part of the eye is called the anterior chamber? The posterior chamber? With what are the chambers lined? Where is the *crystalline* humor situated? With what is it surrounded?

face of each, the convexity varies from their oval character. It is embedded in the anterior part of the vitreous humor, from which it is separated by the hyaloid membrane. It is invested by a transparent elastic membrane, called the capsule of the lens.

The *lens* consists of concentric layers, disposed like the coats of an onion. The external layers are soft, the next firmer, and the central form a hardened nucleus. These layers are best demonstrated by boiling, or by immersion in alcohol, when they separate easily from each other.

The VITREOUS HUMOR forms the principal bulk of the globe of the eye. It is an albuminous fluid, resembling the aqueous humor. It is enclosed in a delicate membrane, named the *hyaloid*, which sends processes into the interior of the globe, forming cells, in which the humor is retained.

Fig. 178.

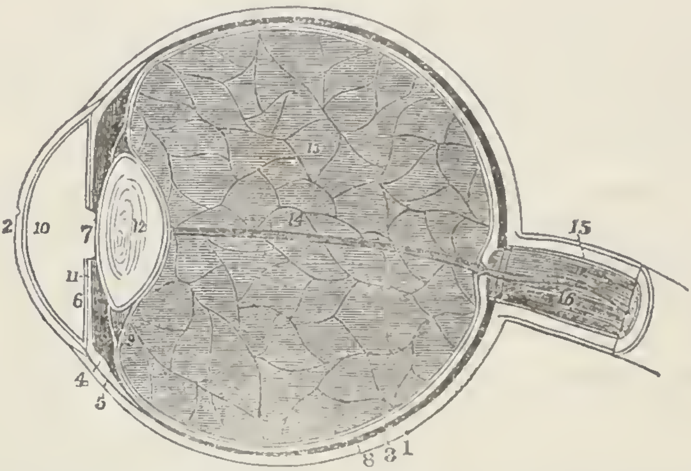

Fig. 178. A longitudinal section of the globe of the eye 1, the sclerotic coat, thicker behind than in front; 2, the cornea received within the anterior margin of the sclerotic, and connected with it by means of a bevelled edge; 3, the choroid coat connected anteriorly with (4) the ciliary ligamant, and (5) the ciliary processes; 6, the iris; 7, the pupils; 8, the third layer of the eye, the retina terminating anteriorly by an abrupt border at the commencement of the ciliary processes; 9, the canal of Petit, which encircles the lens (12;) the thin layer in front of this canal is the zonula ciliaris, a prolongation of the vascular layer to the retina; 10, the anterior chamber of the eye, containing the aqueous humor; the lining membrane by which the humor is secreted is represented in the diagram; 11, the posterior chamber; 12, the lens, more convex behind than before, and enclosed in its proper capsule; 13, the vitreous humor enclosed in the hyaloid membrane, and in cells formed in its interior by that membrane; 14, a tubular sheath of the hyaloid membrane, which serves for the passage of the artery of the capsule of the lens; 15, the neurilemma of the optic nerve; 16, the arteria centralis retinæ, embedded in its centre.

Describe the lens. Describe the *vitreous* humor. What membrane encloses this humor?

PHYSIOLOGY OF THE EYE.

The sclerotic is a tunic that gives form to the body of the eye, and protection to the interior and more delicate parts. The choroid tunic seems to be chiefly composed of a tissue of nerves and minute blood vessels, which give nourishment to the different parts of the eye. The *pigmentum nigrum,* or black paint which lines its inner surface, is of great importance in the function of vision. By it all luminous rays not necessary for vision are absorbed.

In Albinos, where there is an absence of pigmentum nigrum, the rays of light traverse the iris, and even the sclerotic, and so overwhelm the eye with light, that their vision is quite imperfect except in the dimness of evening, or at night.

In the manufacture of optical instruments, care is taken to color their interior black, for the same object, viz., the absorption of scattered rays.

The iris, by means of its powers of expansion and contraction, regulates the quantity of light admitted through the pupil.

If the iris be thin, and the rays of light pass through its substance, they are immediately absorbed by the uvea; and, if that layer be insufficient, they are taken up by the black pigment of the ciliary processes.

The lamellated cornea, the aqueous, crystalline, and vitreous humors, are transparent; so that rays of light traverse these parts of the eye, and fall upon the retina. The office of these humors and the cornea, is, to refract the rays of light in such proportion as to direct the image in the most favorable manner upon the retina.

Different degrees of density modify the refractory power of any transparent medium. It is found on examination, that the cornea, the vitreous, crystalline, and aqueous humors, have each, severally, various degrees of density. The density of the crystalline lens at its circumference

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What is the function of the sclerotic coat? Of the choroid membrane? What is the office of the pigmentum nigrum? What is the effect, when there is an absence of the paint on the choroid coat? Why are optical instruments colored black on the interior surface? What is the function of the iris? What is the character of the humors of the eye? What is the office of the cornea and humors? What is said of the density of the crystalline lens?

varies from its centre. These circumstances modify the direction of the refraction of the rays of light in their passage from the cornea to the retina.

The refracting powers of the plane, convex, concave, plano-convex, plano-concave, and concavo-convex media, are different. The cornea and aqueous humors, are convex-concavo, the vitreous humor is concavo-convex, while the crystalline humor is a double convex medium. The different degrees of convexity or concavity, also modify the refracting character of transparent media. The crystalline lens is of different degrees of convexity on its two sides. The convex surfaces of the aqueous and vitreous humors, are segments of circles of different diameters from their concave surfaces. All these circumstances still further influence the refracting character of the visual organ. The achromatic arrangement of the transparent, refracting media of the eye, remedies the aberration of refraction in the different portions of the eye.

Again, the refracting power of lenses is modified by their convexity or concavity. The more convex a lens is, the shorter the distance from the refracting medium when the different refracted rays converge to a focus. To adapt the eye to view objects at different distances, requires a change in the refracting power of some of the transparent media of the eye. Both surfaces of the crystalline lens are *oval*, not *spherical*, and the refraction of the rays of light is mainly effected in this portion of the eye. Change the inclination of this lens, so that different portions of its anterior surface shall be directly behind the pupil, and its refracting power is increased or diminished, as the surface presented is more or less convex.

To view objects at a distance, a more convex lens is needed, than in examining articles very near the eye. The eye has the power of adaptation to different distances. The action of the *ciliary processes* changes the inclination of the crystalline lens, which modifies the refraction of rays of light, proceeding from objects to which

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What kind of lenses do the various humors exhibit? What modifies the refracting powers of lenses? What is the function of the different lenses of the eye? Has the eye the power of adapting itself to different distances?

the eye is directed. Without this or some other adapting power, a picture of objects at different distances, would not be formed upon the retina, and the vision of every person would be defective, excepting upon objects at certain definite distances from the eye.

The refracting character of differently formed lenses is illustrated in the works on Natural Philosophy, to which the pupil is referred. Where the refracting medium is too great, as in over-convexity of the cornea and lens, the image falls short of the retina, producing near sightedness; and where it is too little, the image is thrown beyond the nervous membrane, producing far-sightedness. These conditions are rectified by the use of spectacles, which provide a differently refracting medium externally to the eyes, and thereby correct the transmission of light.

Vision results from impressions made upon the mind by the picture of an object painted at the back part of the globe of the eye, or on the retina; and the *optic* nerve is the medium of communication between the eye and the brain.

APPENDAGES OF THE EYE.

The appendages of the eye are the *eye-brows*, *eye-lids*, *conjunctiva*, *caruncula lachrymalis*, and the *lachrymal apparatus*.

The EYE-BROWS are two projecting arches of integument, covered with short, thick hairs, which form the upper boundaries of the orbit.

The EYE-LIDS are two valvular layers placed in front of the eye. They have entering into their structure, *integument*, *orbicularis muscle*, *tarsal cartilages*, *meibomian glands*, and *conjunctiva*.

The TARSAL CARTILAGES are two thin lamellæ of fibro-cartilage, about an inch long, which give form and support to the eye-lid.

The MEIBOMIAN GLANDS are imbedded in the internal surface of the cartilages, and are very distinctly seen on

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What is the cause of near-sightedness? Of far-sightedness? How can these defects be remedied? What is the medium of communication between the eye and brain? Name the appendages of the eye. Describe the *eye-brows*. The *eye-lids*. What enter into the structure of the eye-lids? Of what do the *tarsal cartilages* consist? Where are the *meibomian glands* situated?

examining the inner surface of the eye-lids. They have the appearance of parallel strings of pearls. They open by minute foramia upon the edges of the lids.

The secretion from these glands prevents the edges of the eye-lids from being united during sleep.

The edges of the eye-lids are furnished with a triple row of long thick hairs, which curve upwards from the upper lid, and downwards from the lower, so that they may not interlace with each other in the closure of the eye-lids.

The eye-brows are so arranged that they prevent the moisture that accumulates on the forehead, in free perspiration, from flowing into the eye. The eye-lids, by closing, not only protect the eye from moisture, but from dust, particularly during sleep. They likewise, by their movements in opening and shutting, spread the lubricating fluid equally over the eye.

The CONJUNCTIVA is the mucous membrane of the eye. It covers the whole of the anterior surface, and is then reflected upon the lids, so as to form their internal layer. In this membrane is secreted the fluid that moistens and lubricates the eye and which causes the eye lids to open and shut without friction.

The LACHRYMAL APPARATUS consists of the lachrymal gland, with its excretory ducts; the puncta lachrymalia, and lachrymal canals ; the lachrymal sac, and nasal duct.

The LACHRYMAL GLAND is at the upper and outer angle of the orbit. It is about three quarters of an inch in length, flattened and oval in shape, and occupies a fossa in the orbital plate of the frontal bone. Ten or twelve small ducts pass from this gland to the border of the tarsal cartilage of the upper eye-lid, when they open on the surface of the conjunctiva.

The LACHRYMAL CANALS commence at the minute openings seen upon the edge of the eye-lids. These openings are called puncta lachrymalia. The canals terminate in the lachrymal sac.

What do the meibomian glands resemble? With what are the edges of the eye-lids furnished? What is said of the arrangement and use of the eye-brows and lids? Describe the *conjunctiva.* Of what does the *lachrymal apparatus* consist? Where is the *lachrymal* or tear-gland situated? Where do the *lachrymal canals* commence?

Fig. 179.

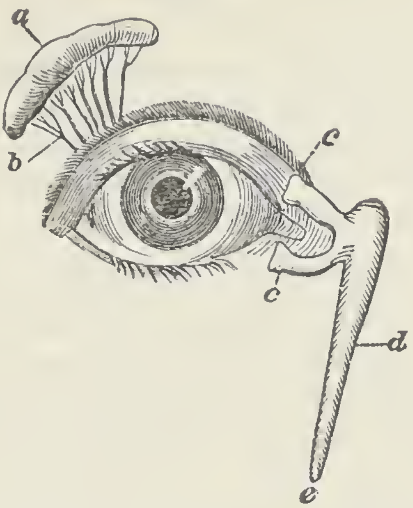

Fig. 179. *a*, is the lachrymal gland; *b*, ducts leading from the lachrymal gland to the upper eye-lid; *c*, *c*, the puncta lachrymalia; *d*, is the nasal sac; *e*, the termination of the nasal duct.

The LACHRYMAL SAC is the upper part of the nasal duct, and is but little larger than the canal.

The NASAL DUCT is a short canal, about three quarters of an inch in length, directed downwards and backwards, to the inferior meatus of the nose, where it terminates by an expanded orifice.

The fluid (tears) secreted by the lachrymal gland, is conveyed to the eye by the small ducts before described. It is then imbibed by the puncta lachrymalia, and carried by the lachrymal canals into the lachrymal sac, from which it is passed to the nasal cavities by the nasal ducts. When the secretion of the lachrymal gland is very copious, as in weeping, the lachrymal canals are too small to convey it to the nasal passages as fast as secreted, and it flows over the cheeks. If the lachrymal canals or nasal ducts become obstructed or obliterated, there is a constant flow of fluid over the cheeks. The opening of the canals or ducts, by a surgical operation, is the only effectual remedy.

A large branch from the fifth pair of nerves, (which is a nerve of sensibility) ramifies upon the different parts of the

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Where is the *lachrymal sac* situated? The *nasal duct?* Where are the tears secreted? Where conveyed? Why do tears flow over the cheeks instead of entering the nasal ducts? What nerves ramify upon the eye?

eye and its appendages. Those parts, however, receive some nervous filaments from the seventh pair. The large number of sensitive nervous filaments renders the visual organ very impressible to bodies that cause irritation, as dust, or intense light. This compels us to use due care to shield the eye from the influence of agents that would impair or destroy vision.

PRACTICAL SUGGESTIONS.

1. Action or use, alternated with rest, should be observed in relation to the eye as well as other organs. If the eye be kept fixed intently, for a long time, on an object, it will become exhausted, and the power of the visual organ diminished. The observance of this rule is particularly needful to those whose eyes are weak, and predisposed to inflammation.

2. Although the iris dilates and contracts, as the light that falls upon the eye is faint or strong, this dilatation or contraction is not instantaneous. Hence, the imperfect vision noticed in passing from a strong to a dim light, and the overwhelming sensation experienced on emerging from a dimly lighted apartment to the bright light of the meridian sun. Sudden transitions should be avoided, as they tend to induce disease, and paralysis of the retina. Likewise, using the eye a long time, in a very intense light, is one of the most common causes of amaurosis, or paralysis of the retina.

3. If the eye is turned obliquely in viewing objects, it may produce an unnatural contraction of the muscle called into action. This contraction of the muscle is termed *strabismus*, or cross eye. The practice of imitating the appearance of a person thus affected, is injudicious, as the imitation designed to be temporary, may become permanent. For the same reason, a young child should not be permitted to examine objects by turning its eye obliquely.

4. Any action, unnatural to the muscles, if frequently repeated, may and will modify the character and action of the parts so operated upon. If a limb, as the arm, be

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Why is the eye so impressible? Do the same principles apply to the eye as to the muscular system? What is the effect, if the eye be kept in one position a long time? How is amaurosis, or decay of sight, often produced? How is the cross eye frequently produced?

kept flexed for a long time, one set of muscles will be relaxed and elongated, and another will be shortened, and its contractile power will be increased. The same principle is true of the eye. In viewing objects very near the eye, the ciliary processes are called into action to produce a proper inclination of the crystalline lens, so that the rays of light may be properly refracted to form a perfect image on the retina. In looking at objects at a great distance, the ciliary processes are called into a different action to produce a different inclination of the lens. Let either of these actions be repeated, again and again, for weeks and months, and they will become natural, and the acquired inclination will be permanent. Hence, a person becomes near or long sighted, as the objects to which the eye is usually directed are near or remote. This is one reason why scholars, watchmakers, and artisans, who bring minute objects near the eye to examine them, are near-sighted, and why hunters and sailors, who are habituated to view objects at a distance, are long-sighted. Children should be trained to use the eye upon objects at different distances, so that the vision may be correct when objects at various distances are viewed.

SENSE OF HEARING.

Anatomy of the ear.

The ear is composed of three parts. 1. The *external ear.* 2. The *middle ear*, or *tympanum.* 3. The *internal ear*, or *labyrinth.*

The external ear.

The EXTERNAL EAR consists of two portions, the *pinna* and *meatus.*

The AUDITORIUS PINNA is a kind of funnel, which collects the vibrations of the atmosphere, which vibrations are called sounds.

The MEATUS AUDITORIUS is a canal partly cartilaginous and partly osseous, about an inch in length, which extends inwards from the pinna to the tympanum. It is

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Why are artisans and scholars generally near-sighted? Why are sailors and hunters long-sighted? How should children be taught to view objects? Of how many parts is the ear composed? Of what does the external ear consist? Describe the *pinna.* The *meatus auditorius.*

narrower in the middle, than at each extremity. It is lined by an extremely thin pouch of cuticle, which, when withdrawn, after maceration, preserves the form of the meatus. Some stiff, short hairs are also found in the interior of the meatus, which stretch across the tube, and prevent the ingress of insects. Beneath the cuticle are a number of small *ceruminous follicles*, which secrete the wax of the ear. The external ear is plentifully supplied with blood vessels, and nerves from the fifth pair.

Fig. 180.

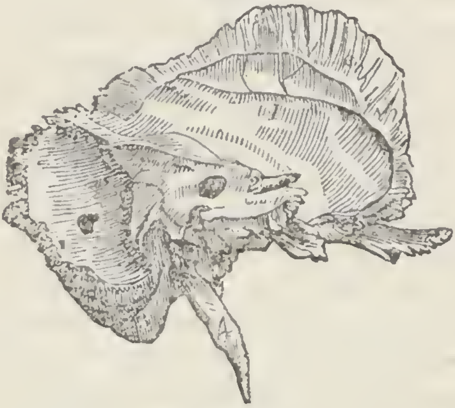

Fig. 180. 1, The squamous or thin portion of the temporal bone ; 2, 2, the petrous portion ; 3, the mastoid process behind the ear ; 4, the styloid process.

The Middle Ear.

The TYMPANUM is an irregular, bony cavity, situated within the temporal bone. It is bounded externally by the meatus and membrana tympani ; internally, by its inner wall ; and in its circumference, by the petrous bone and mastoid cells.

The MEMBRANA TYMPANI, or drum of the ear, is a thin semi-transparent membrane, of an oval shape. It is about three-eighths of an inch in diameter. It is inserted into a grove around the circumference of the meatus, near to its termination. It is placed obliquely across the area of that tube. It is concave towards the meatus, and convex towards the tympanum. It is composed of three layers

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What are found in the interior surface of this canal, and what is their use ? Where are the ceruminous follicles ? What does Fig. 180 represent ? Describe the *tympanum*. What surface does the membrani tympani present externally ? What internally ? Of how many layers is the drum of the ear composed ?

—an external *cuticular;* a middle *fibrous* and *muscular;* and an internal *mucous.*

The tympanum contains four small bones, *ossicula audita*, named separately, the *malleus, incus, stapes* and *orbicular.*

Fig. 181.

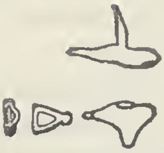

Fig. 181 represents the *four* bones of the ear. The smallest is represented magnified. This bone is early matured, and in the adult it becomes united with the incus. These bones are retained in their places and moved by three ligaments and four muscles.

There are ten openings into the tympanum or middle ear; five large and five small openings. The larger openings are the *meatus auditorius, Fenestra ovalis, Fenestra-rotunda, Mastoid cells,* and *Eustachian tube.*

Fig. 182.

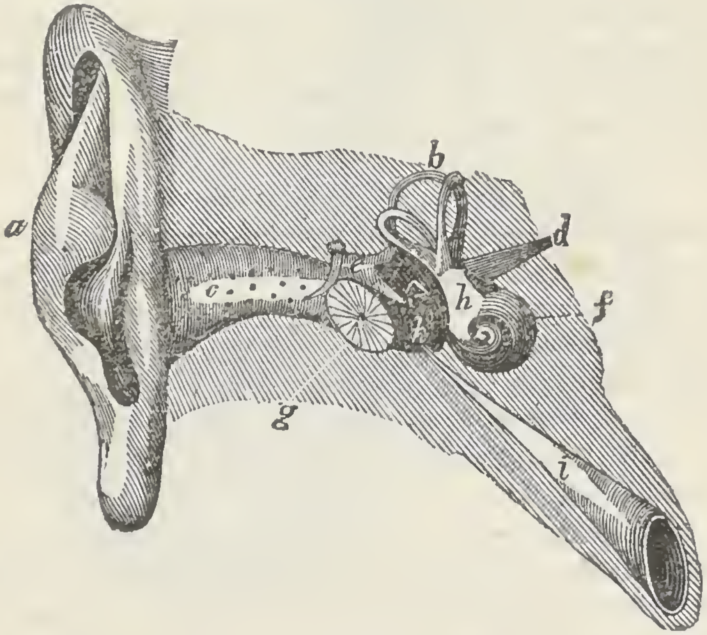

Fig. 182. *a*, The pinna; *c*, the meatus auditorious; *g*, the membrana tympani; *h*, the tympanum; *e*, the ossicula audita; *b*, the semicircular canals; *f*, the cochlea; *h*, the vestibule; *i*, the eustachian tube; *d*, the auditory nerve. Let the student describe the external and middle ear, from this engraving.

Name the layers of which the drum of the ear is composed. How many bones are contained in the tympanum? What is said of the orbicular or smallest bone of the ear? How many openings into the middle ear? Name them. Describe Fig. 182.

The *Fenestra ovalis* is the opening of communication between the tympanum and the vestibule. It is closed by the foot of the stapes, and by the lining membrane of both cavities.

The *Fenestra rotunda* serves to establish a communication between the tympanum and the cochlea. It is closed by a proper membrane, as well as by the lining of both cavities.

The *Mastoid cells* are very numerous, and occupy the whole of the interior of the mastoid process, and part of the petrous bone. They communicate, by a large, irregular opening, with the upper and posterior circumference of the tympanum.

The *Eustachian tube* is a canal of communication, extending obliquely between the pharynx and the anterior circumference of the tympanum. In structure it is partly fibro-cartilaginous and partly osseous. It is broad and expanded at its pharyngeal extremity, and narrow and compressed at the tympanum.

The small openings are, 1. For the entrance of the chorda tympani; 2. for the exit of the chorda tympani; 3, 4, and 5, for the muscles that act upon the membrana tympani, and bones of the ear.

The internal ear.

The internal ear is called the labyrinth, from the complexity of its communications. It consists of a membranous and an osseous portion. The osseous labyrinth presents a series of cavities which are channeled through the substance of the petrous bone. It is situated between the cavity of the tympanum and the meatus auditorius internus. It is divisible into the *vestibule*, *semicircular canals*, and *cochlea*.

The VESTIBULE is a small three-cornered cavity, situated immediately within the inner wall of the tympanum. The three corners, which are named ventricles, or cornua, are placed, one anteriorly, one superiorly, and one posteriorly.

The openings of the vestibule may be arranged into

Describe the fenestra ovalis. The fenestra rotunda. The mastoid cells. The eustachian tube. Why is the internal ear called the labyrinth? Describe the osseous labyrinth. Where is it situated? How is it divided? Describe the *vestibule*.

large and *small*. The large openings are seven in number, viz. the Fenestra ovalis, Scala vestibule, and five openings of the three semicircular canals.

The *Fenestra ovalis* is the opening into the tympanum.

The *Scala vestibule* is the oval termination of the vestibular canal of the cochlea.

The SEMICIRCULAR CANALS are three bony passages which communicate with the vestibule, into which two open at both extremities, and the third at one extremity.

The COCHLEA, so called from its resemblance to a snail shell, forms the anterior portion of the labyrinth. It consists of an osseous and gradually tapering canal, about one and a half inches in length, which makes two turns and a half, spirally, around a central axis, called the *modiolus*. The modiolus is large near its base, where it corresponds with the first turn of the cochlea, and diminishes in diameter towards its extremity.

Fig. 183.

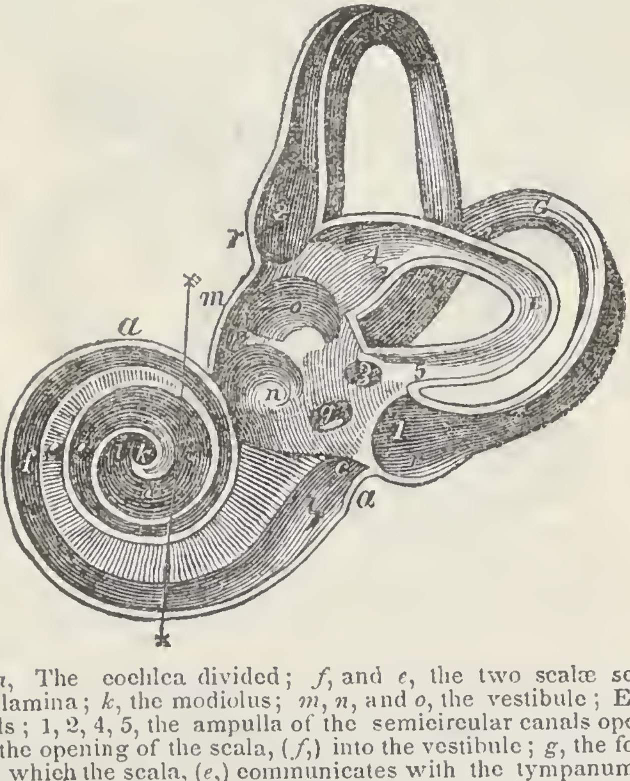

Fig. 183. *a*, The cochlea divided; *f*, and *e*, the two scalæ separated by a membranous lamina; *k*, the modiolus; *m*, *n*, and *o*, the vestibule; E, G, K, semicircular canals; 1, 2, 4, 5, the ampulla of the semicircular canals opening into the vestibule; *c*, the opening of the scala, (*f*,) into the vestibule; *g*, the foramen rotundum, through which the scala, (*e*,) communicates with the tympanum; 3, the foramen ovalis, into which the stapes is placed. Let the student review the text upon the labyrinth, and point out its windings, with this plate before him.

What are the semicircular canals? Why was the name *cochlea* given to the anterior portion of the labyrinth? Of what does it consist? Describe Fig. 183.

The interior of the canal of the cochlea is divided into two passages, by means of a bony and membranous lamina, called the lamina spiral. These two passages are called the small *scalæ*. At the extremity of the modiolus, the two scalæ communicate with each other. At the other extremity, one opens into the vestibule; the other into the tympanum, by the foramen rotundum.

The internal surface of the osseous labyrinth is lined by a fibro-serous membrane.

The *membranous labyrinth* is smaller in size, but a perfect counterpart, with respect to form, of the osseous vestibule and semicircular canals. It consists of two small elongated sacs—one named the *sacculus communis;* and the other, the *sacculus proprius.* The membranous labyrinth is filled with a limpid fluid, first described by Scarpa,—thence named the liquor scarpæ.

The AUDITORY NERVE divides into two branches, at the bottom of the *cul de sac*, or cavity of the meatus auditorius internus,—a vestibular and a cochlear nerve.

Fig. 184.

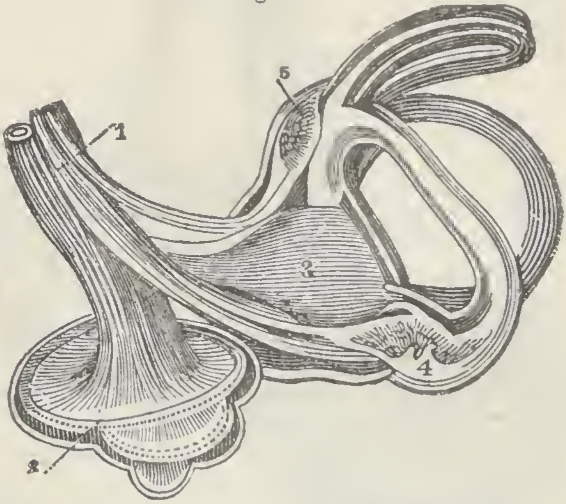

Fig. 184. 1, The auditory nerve, dividing into two large branches in the labyrinth; 2, the cochlear branch, ramifying in the scalæ of this organ; 3, the vestibular branch; 4, 5, branches that ramify upon the membranous semicircular canals.

The two branches of the auditory nerve enter the structure of the *sacculi*, and *membranous labyrinth*, radiat-

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How is the interior of the cochlea divided? With what is the internal surface of the osseous labyrinth lined? What is said of the membranous labyrinth? Where do the vestibular and cochlear nerves originate? Describe the course of these nerves. What does Fig. 184 exhibit?

ing in all directions, anastomosing with each other, forming interlacements and loops. They terminate upon the inner surface of the membrane, in minute papillæ, resembling those of the retina.

Physiology of the Ear.

In *audition*, or hearing, all the organs that have been described are called into action. If any part of them is wanting or defective, audition will be more or less impaired. To better explain the philosophy of audition, figs. 185 and 186 have been inserted.

Fig. 185.

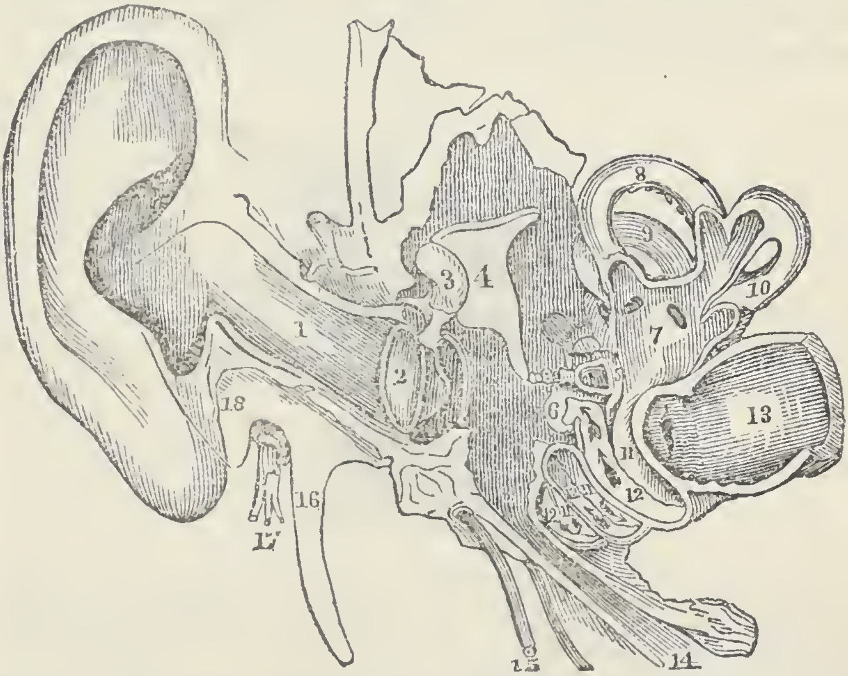

Fig. 185. 1, The meatus auditorius; 2, the membrana tympani; 3, the malleus bone; 4, the incus bone; 5, the stapes, which is placed in the foramen ovalis, an opening into the vestibule, 7; 6, the foramen rotundum; 8, 9, 10, the semicircular canals that open into the vestibule, 7; 11, 11, 11, the scala or canal of the cochlea, that opens into the vestibule of the internal ear; 12, 12, 12, the scala or canal of the cochlea, that connects with the middle ear, through the foramen rotundum, at 6; 13, the meatus auditorius internus; 11, the eustachian tube; 15, the chordi tympani; 16, the styloid process of the temporal bone; 17, the portia dura of the 7th pair of nerves; 18, the mastoid process; 1 and 2 are parts of the external ear; 3, 4, and 5, are the small bones placed in the middle ear; 7, 8, 9, 10, 11, 12, and 13, are parts of the internal ear.

With fig. 185 before the eye, let the pupil describe the different parts of the ear, and their agency in audition.

What is the effect if any organ of the ear is defective? Describe Fig. 185.

Sound, or a wave of air, is collected by the external ear, and conducted into the meatus auditorius, at 1. This wave strikes upon and puts in vibration or motion the membrana tympani, or drum of the ear, 2. The vibration of the membrana tympani is communicated to the malleus, (3,) that lies in contact with it. The bone (3) is bound to the bone (4). The bone (4) to the bone (5). The bone (5) communicates with the vestibule of the internal ear, (7). The vibration is conveyed from the drum of the ear to the fossa of the internal ear, by the chain of bones and in the middle ear. The vibration, which is communicated to the fluid of the labyrinth, is thus impressed upon the delicate expansion of the auditory nerve, which transmits it to the brain.

Fig. 186.

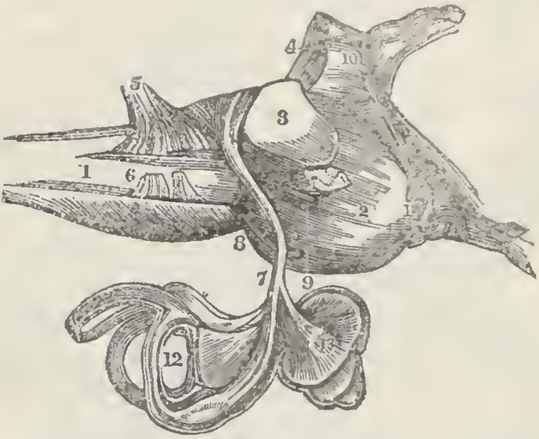

Fig. 186, is a view of the origin and distribution of the portio-mallio of the seventh pair, or auditory nerve. 1, The medulla oblongata ; 2, the pons varolii ; 3, 4, the crura cerebelli of the right side ; 5, the eighth pair of nerves ; 6, the ninth pair ; 7, the auditory nerve, seen dividing into two branches, one of which is distributed in the vestibule and semicircular canals, (12,) and the other in the cochlea (13 ;) 8, the sixth pair of nerves ; 9, the facial nerve of the seventh pair ; 10, the fourth pair ; 11, the fifth pair.

If the meatus (1) be closed, hearing will be destroyed. If the membrana tympani is thickened by viscid wax, its vibration will be diminished and hearing impaired. If the bones, 3, 4, 5, are removed, impaired hearing follows, as sound is not communicated freely from the membrana tympani to the vestibule of the internal ear. If the Eustachian tube be obliterated by inflammation of the throat,

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Describe how sound is communicated through the apparatus of the ear to the brain. What does Fig. 186 exhibit? State some of the causes of deafness.

the vibrations of air in the inner ear will be diminished, and defective audition follows. Disease or destruction of the labyrinth, or auditory nerve, will impair and destroy the sense of audition. Deafness may result from any or all of the above causes.

PRACTICAL SUGGESTIONS.

Like all our other senses, hearing is capable of very great improvement by cultivation, and acute audition requires perfection in the structure and functions of the different parts of the ear, and that portion of the brain from which the auditory nerve proceeds. Defective audition is by no means unfrequent. To some of the common causes of imperfect hearing we now invite the reader's attention.

1. The structure or functional action of the brain may be deranged by inflammation, by compression, or by debility. The first is seen during inflammatory affections of the brain, and in fevers; the second is seen in accidental injuries of the head; the third is seen in old age, and after severe diseases of the head and fevers. In these cases, applications to and operations upon the ear do no good. The only remedy is to remove, if possible, the diseased condition of the brain.

2. Imperfect hearing may be produced by destruction of the membrana tympani, or removal of the ossicula audita, or the parts within the labyrinth. In these instances, medical treatment is of no avail, as the destroyed parts cannot be restored.

3. Audition may be rendered defective, by a diminution of the vibratory character of the membrana tympani. This may result from thickening of this membrane, or from accumulation of wax upon its outer surface. The increased thickness is usually the result of inflammation, either acute or chronic. The proper treatment is such as is efficient to remove inflammatory action. The introduction of heads of pins into the ear, is a frequent cause of chronic inflammation of the membrana tympani. Hence, this practice should never be adopted, and if acquired,

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Can hearing be improved by cultivation? What is necessary to acute audition? Name one cause of defective hearing. Another. What is the third cause that is mentioned? What is said of the introduction of pins to cleanse the ear?

should be abandoned. The accumulations of viscid wax may be softened by dropping some animal oil into the ear, and then removing it, by injecting warm soap suds into the ear a few hours subsequent to the use of the oil.

4. The sense of hearing may be impaired by obstruction of the Eustachian tube. The closure of this canal diminishes the vibratory character of the air within the tympanum, in the same manner as closing the opening in the side of a drum. Hearing is as much impaired by closing the Eustachian opening, as the tones of a drum are by obstructing the side apertures. And for the same reason, enlarged tonsils, inflammation and ulceration of the fauces and nasal passages, during and subsequent to scarlet fever, and the inflammation attending the *sore throat* in common colds, are the common causes of this obstruction. The treatment of such cases of defective hearing, is to have the tonsils, if enlarged, removed by a surgeon; the inflammation and the thickening of the parts removed by remedial means directed by an understanding physician. A large proportion of the cases of defective audition among young and middle-aged persons, are caused by obstruction of the Eustachian tube, and can be relieved by the application of proper means.

What is the remedy where there is an accumulation of wax? Name the fourth condition by which audition is impaired. Why does the closing of this canal affect the hearing? What is the treatment where there are enlargements or ulcerations in the throat?

CHAPTER XII.

ABSORPTION, SECRETION, NUTRITION, AND ANIMAL HEAT.

ABSORPTION is a process by which food and drinks, designed for the growth and nourishment of the body, are imbibed and carried into the system. Those particles and materials that have been already deposited, and have become injurious or useless, are conveyed from the mass of fluids, and removed from the system. The absorption necessary for the growth of the human body, is effected by the action of the *lacteals* and *thoracic duct*, (described in the chapter upon the Anatomy and Physiology of the Digestive Organs.) The absorption that removes injurious matter from the human body, is effected by the action of *lymphatic vessels* and *lymphatic glands.*

ANATOMY OF THE LYMPHATIC VESSELS AND GLANDS.

These vessels arise not only from the surface of the skin and mucous membranes, the cavities of the chest, abdomen, pericardium, and joints, but also from the ventricles of the brain. They are extremely minute at their origin, so that in many parts they cannot be detected without the aid of a microscope. As they proceed, they unite and form larger trunks, which open into the large veins near the heart.

The walls of these vessels have two coats, of which the external one is cellular, and is capable of considerable distension. The internal coat is folded so as to form valves, like those in the veins. Their walls are so thin,

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Define *absorption.* By what vessels is the absorption necessary for the growth of the system, effected? Those that remove injurious matter from the system? Where do the lymphatic vessels arise? Describe these vessels. How many coats have they? What of the external coat? The internal?

that these folds give them the appearance of being knotted. At certain points the lymphatic vessels pass through distinct, soft bodies, peculiar to themselves, which are called *lymphatic glands.* These glands vary in form and in size. They are extremely vascular, and appear to consist of a congerie of minute vessels. Lymphatic glands are found in different parts of the body, but they are most abundant in the groins, axilla, or arm-pits, neck, and cavities of the thorax and abdomen.

Fig. 187.

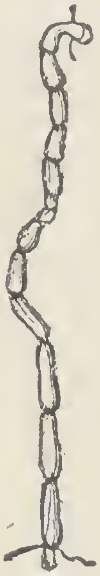

Fig. 188.

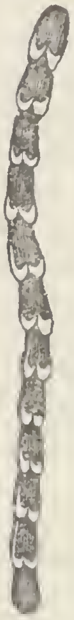

Fig. 189.

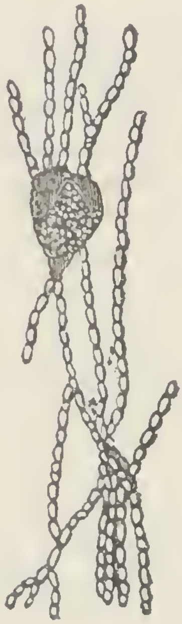

Fig. 187 represents a single absorbent vessel, much magnified.
Fig. 188 represents the valves of a lymphatic trunk.
Fig. 189 represents several absorbent vessels passing through a lymphatic gland.

The coats of the lymphatics are supplied with nutrient arteries, veins, and ganglionic nerves.

PHYSIOLOGY OF THE ABSORBENTS.

Many experiments have proved that the skin may absorb sufficient nutrition to support life for a time, by immersing the patient in a bath of milk or broth. Thirst may be quenched by applying moist clothes to the skin,

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Have the lymphatic vessels glands? Describe the lymphatic glands. Where are they most abundant? Do these vessels inosculate? With what are the coats of the lymphatics supplied? May life be supported by absorption through the skin?

or by bathing. It is no uncommon occurrence that the saliva becomes bitter by the absorption of sea water, in passing from one continent to the other. It has been

Fig. 190.

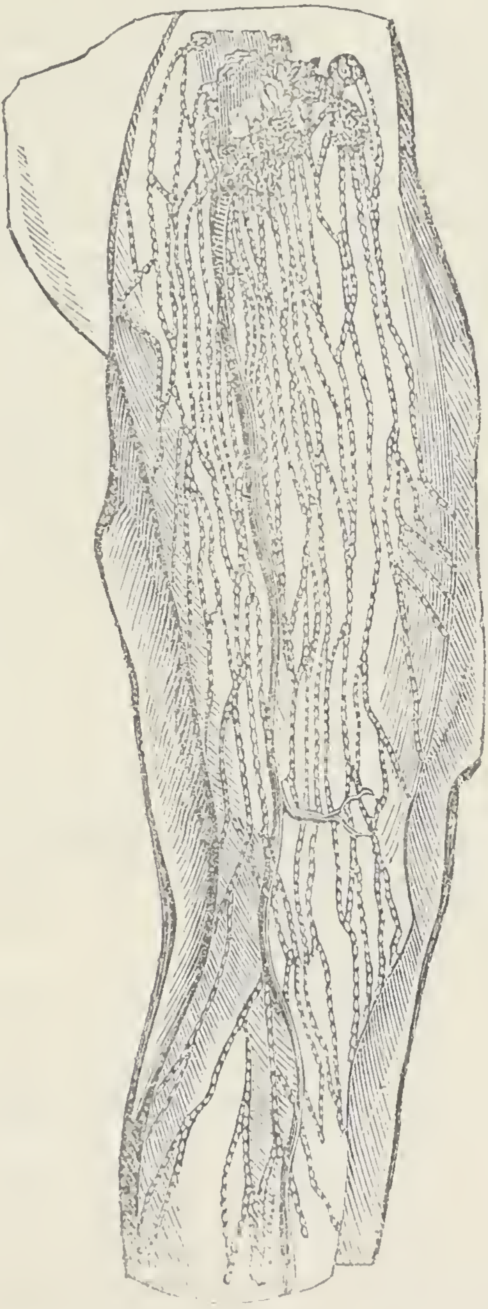

Fig. 190. A representation of the absorbents of the anterior part of the thigh.

found that the hand, immersed to the wrist in warm water, will absorb from ninety to one hundred grains of fluid in the space of an hour. Medicinal substances, such as mercury, morphine, and Spanish flies, are frequently introduced into the system through the skin.

The alimentary canal is supplied not only with lacteals, but also with lymphatic vessels. These, and the venous radicles, absorb fluids brought in contact with them, as water, alcohol, &c.

The mucous membrane of the lungs is abundantly supplied with absorbents. By their action, substances finely pulverized, or in the form of gas, are readily imbibed when inhaled into the lungs, such as metallic vapors, odoriferous particles, marsh and other effluvia. In this way, contagious diseases are frequently contracted.

Physiologists have given to absorption different names, according to the different functions which the vessels perform. *Interstitial* absorption is that change of the particles of matter of which every organ is composed, either to remove the decayed atoms, or repair the waste which is constantly going on in the animal economy. The action of those vessels counterbalances those of nutrition, and thus the form and size of every part of the body is preserved. When their action exceeds those of the nutrient vessels, the body emaciates; when it is deficient, plethora is the result. In youth, they are less active than the nutrient vessels, but in later periods of life we find these actions reversed, and the body diminishes in size. It is not unfrequent that tumors of considerable size disappear, and even the entire bone of a limb has been removed from the same general cause.

Recrementitial absorption is the removal of those fluids from the system, which are secreted upon surfaces that have no external outlet. These fluids are various, as the fat, the marrow, the synovia of joints, serous fluids, and

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How much fluid will the hand immersed to the wrist absorb in an hour? How are medicinal substances frequently introduced into the system? With what vessels is the alimentary canal supplied? Are absorbents found in the mucous membranes? Are diseases ever contracted by inhaling vapors and gases? How? What is interstitial absorption? What is said of these and the nutrient vessels? Which is the most active in youth? In old age? What is recrementitial absorption?

the humors of the eye. Were it not for this variety of absorption, dropsy would generally exist in the cavities of the brain, chest, and abdomen, from the continued action of the secretory vessels.

Excrementitial absorption relates to the fluids which have been excreted, such as the bile, pancreatic fluid, saliva, milk, and other secretions. *Cutaneous* absorption relates to the skin; *respiratory*, to the lungs.

All these varieties of absorption are maintained through life, except when suspended by disease. Thus by absorption in the lungs, oxygen is converted into one of the elements of the blood; in the tissues of the organs, solid particles are converted into a fluid called lymph.

ANATOMY OF THE SECRETORY ORGANS.

There are three kinds of secretory organs, viz: the *exhalent vessels*, the *follicles*, and the *glands*.

The EXHALENTS are supposed to be the termination of the arteries, or capillaries. They are of two kinds, external and internal. The latter terminate on the surfaces within the body, and the former upon the outside.

Fig. 191.

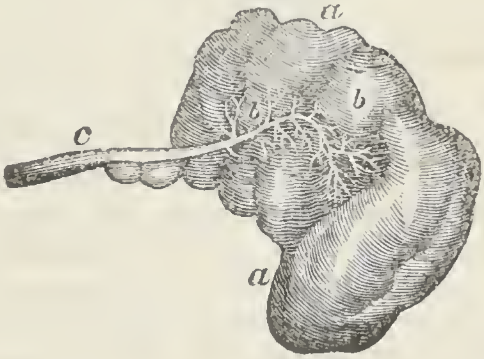

Fig. 191. *a*, *a*, represents a secretory gland; *b*, *b*, minute ducts that are spread through the gland. These coalesce to form the main duct, *c*.

The FOLLICLES are small bags or sacs, in the true skin

What is excrementitial absorption? Are these varieties of absorption maintainable through life? Name some of the changes which absorption produces. Name the secretory organs. What are the *exhalents* supposed to be? How many kinds of exhalent vessels?

and mucous membranes. The pores seen on the skin are the outlets of these follicles. These sacs are supplied with veins and organic nerves.

The GLANDS are the chief agents of secretion in the body. They are of various sizes, and generally of a rounded form. Every gland is supplied with arteries, veins, lymphatics, and nerves, arranged in a peculiar manner, and connected together by cellular membrane.

Fig. 192.

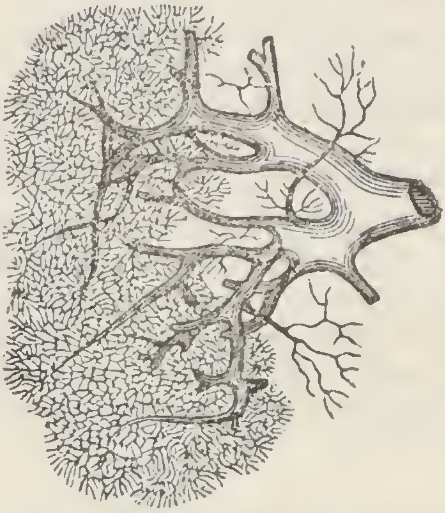

Fig. 192 represents an artery and its ramifications in a secretory gland.

PHYSIOLOGY OF THE SECRETORY ORGANS.

Secretion is one of the most obscure and mysterious functions of the animal economy. To *secrete* means to *separate.* Most of the fluids formed by this process did not previously exist in the blood, but only the elements out of which they were made. It is purely a *vital,* and not a *chemical* or *mechanical* process. The vessels by which it is accomplished may well be called the architects and chemists of the system; for out of the same material — the *blood* — they construct a variety of wonderful fabrics and chemical compounds.

We see the same wonderful power possessed also by vegetables; for out of the same materials the olive pre-

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Where are the *follicles* found? What are the chief agents of secretion in the animal economy? With what is each gland supplied? Design of Fig. 192? Define secretion. What kind of process is it?

pares its oil, the cocoa-nut its milk, the cane its sugar, the poppy its narcotic, the oak its green pulpy leaves, its light pith, and its dense woody fibre. All are composed of the same, few, simple elements, arranged in different order and proportions.

In like manner, we find the vessels, in animal bodies, capable of forming all the various textures and substances which make up the frame; the cellular tissue, the membranes, the ligaments, the cartilages, the bones, the marrow, the muscles with their tendons, the lubricating fluid of the joints, the pulp of the brain, the transparent jelly of the eye; in short, all the textures of the various organs of which the body is composed, consist of similar ultimate elements, and are manufactured from the blood.

It is asserted by some physiologists, that many of the secretions exist ready formed in the blood; but they have not been detected by analysis. In proof of this, two ounces of bile were injected into the veins of a dog, and the blood of the animal was analyzed a few moments after, but exhibited no trace of bile.

The proof that secretion is a *vital* process, is, that it is so much influenced by the nervous system. It is no uncommon occurrence, that the nature of milk will be so changed from the influence of anger in the mother, as to cause vomiting, colic, and even convulsions, in the infant that swallows it. Sudden intelligence of the loss of friends or property will suspend the secretion of the gastric fluid, and thus destroy the appetite. Some mental agitation, as fear, will cause a cold sweat to pervade the surface of the body.

Let the nerves which are distributed to any organ be divided, and the function of secretion will be suspended. The changeful states of the nervous system is undoubtedly the reason, that the secretions vary so much in quality as well as quantity, at different periods.

All the blood distributed to the different glands is similar in composition and character, but the fluids secreted by them, vary in appearance in a remarkable degree.

Have vegetables the same property of secretion? Illustrate this. Do the textures of the various organs consist of similar elements? Made from what? What is asserted by some physiologists? Is it true? What proof that it is a vital process? Are the products of secretion similar throughout the different glands?

The yellow, ropy fluid, called bile, the insipid saliva, and the saline tears, are products of different secretory glands.

Fat is a secretion, which is thrown out, in a fluid state, from the cellular membrane. It is deposited in little cells, and exists in the greatest abundance between the skin and the muscles. It forms a cushion around the body, and thus protects it from external injuries, as well as the extremes of heat and cold.

When little or no food is taken into the stomach, life is supported by the absorbent vessels imbibing the fat, and reconveying it into the circulatory system. It is the removal of this secretion which causes the sunken cheek and hollow eye, in a person recovering from a fever. In consumption, the extreme attenuation of the limbs is caused by the absorption of not only the fat, but also the muscles and more solid parts of the system. Animals which lie in their burrows in a half torpid state during the winter, derive their nourishment from the same source.

The *marrow*, seen in the cavities of the long bones, is very much like fat. This is a secretion from a thin delicate membrane, that lines the cavities of the bones. These are the principal internal exhalations or secretions.

There are two external secretions, viz., one from the skin, called perspiration, and the other from the lungs. (See Chapter upon the Skin.) The secretion from the lungs is similar to that of the skin.

When any substance is imbibed by the absorbent vessels, and conveyed into the blood, which is not demanded for nutrition, or does not give nourishment to the system, it is eliminated by secretions. A few years since, a poor inebriate was carried to a London hospital in a state of intoxication. He lived but a few hours. On examining his brain, nearly half a gill of fluid, strongly impregnated with *gin*, was found in the ventricles. This was *secreted* from the vessels of the brain.

Unless the secretions are regularly maintained, disease will be the ultimate result. Let the secretions from the skin be suppressed, and fever, or some internal inflammation

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What is fat? What is its use? How is the system maintained in fevers? Why the emaciation in consumption? What is marrow? Relate the incident at the London Hospital a few years since. Can health be maintained if the secretions be suppressed?

will follow. If the bile be impeded, digestion will be impaired. If any other secretion be suppressed, it will cause a disarrangement in the various internal organs. Ardent spirits derange the secretions, and change the structure of the brain. This is one reason why inebriates do not live to advanced age.

NUTRITION.

'NUTRITION is that process by which the waste of organs is repaired, and by which their development and growth are maintained. Respiration, digestion, circulation, absorption, and secretion, are but separate links in the chain of nutrition, which would be instantly destroyed by the absence of any one of them.

'In the construction of a machine, or an instrument, designed to last for many years, the mechanist seeks for the most durable materials. In making a watch, for instance, he forms the wheels of *brass*, the spring and barrel chain of *steel*, and for the pivot, which is subject to incessant friction, he employs the hardest of all materials,—*the diamond.* The necessity for this arises from the fact, that such instruments do not contain, within themselves, the power of repairing their own losses.

'But far different is the case with the *animal machine.* In order to qualify it for exercising the functions of life, it must be so constructed as to render it capable of continual alterations, displacements, and adjustments; and these subject to continual variation, according to the stage of growth, and also to the different circumstances in which it may be placed. Instead, therefore, of a few elementary bodies, or their simpler combinations, nature has employed such compounds as admit of greater change, and a more variable proportion of ingredients, and greater diversity in the mode of combination. It is nutrition that moulds these materials, and forms these ever-changing compounds, and so preserves the animal machine amid the varying changes of condition to which it is subject.'

The ever-changing state of the system, is shown by giving animals colored matter, mixed with their food, which in a short time tinges their bones with the same

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What is one reason why alcohol shortens life? What is *nutrition*? By what function is the system maintained in its ever-changing state? Give some proofs of the constant change in the system.

color as the matter introduced. Let it be withdrawn, and in a few days the bones will assume their former color—evidently from the effects of absorption. The changeful state of the body is further shown, by the losses to which it is subjected; by the necessity of aliment; by the emaciation which follows abstinence from food.

Every part of the body is subject to this constant change of material. While the lymphatics are removing the decayed atoms of matter from the system, the capillaries are repairing the loss, by depositing bone, muscle, cartilage, nerve, tendon, fat, ligament, membrane, hair, and nails. These changes are effected with such regularity, that the size, shape and appearance of every organ is preserved; so that, after an interval of a few years, there may not remain a particle of matter which existed in the system at a former period. Notwithstanding this entire change, the personal identity is never lost.

'Those animals which are most complicated in their structure, and are distinguished by the greatest variety of vital manifestations, are subject to the most rapid changes of matter. Such animals require more frequent and more abundant supplies of food, and in proportion as they are exposed to the greater number of external impressions, so will be the rapidity of this change of matter.

Animals may be situated so that they lose nothing by secretion or evaporation; consequently, they will require no nutriment. *Frogs* have been taken from fissures in solid lime rock, which were imbedded many feet below the surface of the earth, and on being exposed to the air, exhibited signs of life. How the vital principle was preserved, when they had probably remained there for centuries, is not easily explained.

The *blood* contains all the materials of nutrition. The process by which the food is changed into blood, has been already explained. As it goes the round of the circulation, the nutrient, capillary vessels select and secrete those parts which are similar to the nature of the structure, and the other portions pass on; so that every tissue imbibes and converts to its own use, the very principles which it requires for its growth; or, in other words, as the

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Why does not a person lose his identity in the exchange of materials? What animals are subject to the greatest changes of matter? What is related of frogs? What contains the materials of nutrition?

vital current approaches each organ, the particles appropriate to it, feel its attractive force, — obey it, — quit the stream,—mingle with the substance of its tissue,—and are changed into its own true and proper nature.'

Thus, if a bone be broken, or a muscle or a nerve be wounded, and if the system be in a proper state of health, the vital economy immediately sets about healing the breach. The blood which flows from the wounded vessels, coagulates in the breach, for the double purpose of stanching the wound, and of forming a matrix for the regeneration of the parts. Very soon, minute vessels shoot out from the living parts, into the coagulum of the blood, and immediately commence their operations, and deposit bony matter where it is required to unite fractured bones, and nervous substance to heal the wounded nerve, &c. But the vital economy seems not to possess the power of reproducing the true muscles, and therefore, when any fleshy part has been wounded, its breach is repaired by a gelatinous substance, which gradually becomes hard, and sometimes assumes something of a fibrous appearance. It, however, so perfectly unites the divided muscle as to restore its functional power.

The accumulation of adipose matter in the human body, always evinces more or less of diseased action in some of the organs concerned in the general function of nutrition, and can only be carried to a very limited extent without degenerating into serious disease, which terminates in dropsy or apoplexy, or reacts with violence on some of the digestive organs. Hence, almost every animal which is fatted and killed for food, is in a state of disease when butchered. And it is by no means an uncommon occurrence that fatted hogs die of disease when just about to be killed for the market.

Before the body has attained its full growth, the function of nutrition is very active; a large amount of food is taken, to supply the place of what is lost by the action of the absorbents, and also to contribute to the growth of

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When a bone is broken by what process is it healed? Point out the manner in which it is accomplished. What occurs when a muscle is divided? What does the accumulation of adipose matter in the human system always evince? What is said of the animal food that is usually found in our markets? When is nutrition most active?

the body. In middle age, nutrition and absorption are more equal; but in old age, the absorbents are more active than the nutrient vessels. The size, consequently, diminishes; the parts grow weaker; the bones more brittle; the body bends forward, and every function exhibits marks of decay and dissolution.

A striking instance of active absorption in middle age, was exhibited in the person of Calvin Edson of Vermont, who was exhibited in the large towns of New England, as the 'living skeleton.' In early manhood he was athletic, and weighed one hundred and sixty pounds; but the excessive action of the absorbents over the nutrient vessels reduced his weight, in the interval of eighteen years, to sixty pounds.

Instances, on the other hand, have occurred, of the action of the nutrient vessels exceeding, in an extreme degree, those of absorption; as in the person of a colored girl, thirteen years of age, who was exhibited in New York, in the summer of 1844. She was of the height of misses at that age, but weighed five hundred pounds. Several cases are on record of men weighing eight hundred pounds.

ANIMAL HEAT.

The true sources of animal heat, or calorification in animal bodies, are yet imperfectly known; and it is doubtful whether we shall ever be able to penetrate the veil which conceals the wonderful operations of vital chemistry. Why the temperature of the body is maintained at an average of ninety-eight degrees, and this too under all climates and seasons, has eluded the researches of all physiologists.

Various theories have existed. It was once believed that the heart was the great *furnace* of the system, and that the chief office of respiration was to *cool the blood.* The hypothesis of Mr. Black was, that respiration is a kind of combustion, by which all the heat of the body is generated. If this be *strictly true*, the heat of the lungs should be much greater than other parts of the system.

How in middle age? How in old age? Relate a striking instance of active absorption in middle age. Of excessive nutrition in early life. Are the sources of animal heat known? What is the average temperature of the body? What was one theory in regard to the source of animal heat? What was Mr. Black's hypothesis?

It is found by experiment, that arterial blood is warmer than venous. The blood acquires about one degree of heat in passing through the lungs. If the blood pass through the lungs twenty times an hour, the system will receive from respiration twenty degrees of heat, or two hundred and forty degrees every twelve hours.

Mr. Brodie's hypothesis was, that animal heat depends on, or is produced by, nervous influence. He showed by some experiments, that in decapitated animals, the temperature fell more rapidly, when respiration was sustained artificially, than when it was not.

Another class of physiologists maintain, that animal heat is generated in the capillary system. This theory receives some support from the fact, that there is some increase of heat in the part, when a portion of the system is irritated or inflamed.

Observation and experiment show, that heat is produced by an action among the molecules, or atoms of the system. In respiration, carbon passes from the system, and oxygen is received. This change of matter is attended by a change of temperature. In nutrition, fluids are converted into solids; in absorption, solids are changed into fluids; in secretion, compounds are decomposed and new ones formed; in digestion, food is changed into the fluid chyle. In all these processes, animal heat is generated. All of these changes are effected in the capillary vessels, and all require a certain amount of pure blood and nervous fluid.

It may be concluded, then, that respiration, circulation, and nervous influence, all coöperate in producing animal heat, or that they are conditions essential to this phenomenon.

Which has most heat—arterial or venous blood? How much is the temperature of the blood increased in passing through the lungs? How much heat will the system receive in an hour, allowing twenty respirations each minute? In twelve hours? What is the supposition of Mr. Brodie? What is another theory? What do observation and experiment show? What functions co-operate in the production of animal heat?

APPENDIX.

The subject of this Appendix is the practical treatment of *Burns, Scalds, Wounds, Poisons,* and other accidents which are daily occurring in the community. To meet these exigences, requires information and premeditation. The boy and girl should be so instructed, that they can render assistance to persons suffering from accidents, as well as the person of mature years. In most of these everyday occurrences, much pain, and even death may be prevented, by the prompt and proper assistance of some individual who may be present, before a surgeon or physician can be called.

BURNS AND SCALDS.

When a certain degree of heat is applied to the skin, the action of its vessels will be more or less changed. This is seen under these conditions: 1. When the nerves are simply irritated, and the blood-vessels distended with blood, attended with severe smarting pain, applications should be applied, to prevent blistering; as blisters are produced by an increased action of the arteries of the skin, which action deposits serum under the cuticle. If this state of the arteries be prevented or suppressed, vesication will not follow.

To prevent or suppress this state of arterial action, *wet some folds of cotton or woollen cloth with cold water,* and apply it to the parts scalded; continue to apply cold water, so as to steadily maintain the low temperature of the applications, as long as the smarting pain is experi-

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Should the boy and girl, as well as persons of mature years, be taught how to render proper assistance when a person is burned, or in other accidents of almost daily occurrence? What is the effect of a certain degree of heat applied to the skin? Mention the first condition. How are blisters produced? How can vesication be prevented?

enced. The *steady* application of cold dressing tends to prevent an increased action of the blood-vessels, and will suppress it, if it already exist.

2. When blisters are formed, the cuticle is separated from the other tissues of the skin, by the effusion of serum. In all cases, if the cuticle be not removed, give exit to the effused serum by making a small opening in the raised cuticle. Under such circumstances, never remove the cuticle, as it makes the best possible covering for the blood-vessels and nerves of the true skin. The cold water dressing recommended above, may then be applied as long as the smarting continues. After the pain has subsided, the blistered part may be covered by a patch of cotton or linen cloth, upon which a cerate, or ointment, made of lard and bee's-wax, has been spread.

3. If the cuticle has been removed, there will be much suffering, because the nerves are unduly stimulated by the air. The cuticle is the sheath or covering of the vessels and nerves of the skin. When it is removed, a substitute should be applied. This substitute should be soothing, and cover the denuded surface. Linseed meal, or ground slippery elm bark poultice, would make a good dressing; so would fresh cream, or lard and bee's-wax, spread upon linen or cotton cloth. When dressings are applied, they should not be removed until they become dry and irritating. If there be much suffering, administer to an adult from twenty-five to sixty drops of laudanum, according to the severity of the pain. If the patient be a child, from fifteen drops to a tea-spoonful of paregoric may be administered. When there is much prostration, some hot peppermint tea, a little hot wine, or brandy and water, may be found necessary to bring on reaction.

FREEZING, OR FROST BITE.

The hands, feet, ears, &c., are subject, in cold latitudes, to frost bite. This may occur without the patient, at the moment, being aware of it.

The part affected at first assumes a dull red color, which gradually gives place to a pale, waxy appearance, and becomes quite insensible.

What should be the treatment if a blister has been formed? What should be the treatment when the cuticle has been removed? How often should the dressing of burns be removed? What is the appearance of limbs while freezing?

The first thing to be done in such cases, is, to reëstablish the circulation in the part. This may be accomplished by rubbing it with *snow*, or when not to be obtained, *cold* water; but the snow is always to be preferred. The fire should be avoided; and it would be better for the patient, to be kept in a cold room for a time, where there is no fire, or where the temperature is moderate.

A person may be found by the road-side, benumbed with the cold, and be almost or quite insensible. Such a person should be taken into a *cold* room, his clothes removed, and friction commenced, and continued for some time, with snow. When warmth begins to be restored, he should be rubbed with a dry flannel, and the friction continued until reaction takes place. As soon as the patient is sufficiently revived to be able to swallow, give a little warm drink, as ginger tea, or weak wine and water. The patient should then be placed in a *cold* bed.

The after-treatment should be conducted by a surgeon. If the frozen parts are followed by blisters, treat them as directed in the section on burns.

ASPHYXIA FROM DROWNING.

As cases of drowning are frequent, and the recovery of the body often so speedy, life, in many instances, might be restored, if the proper means were resorted to in season. It is very important that every member of the community should be made acquainted with the proper mode of proceeding in such cases. The following directions are given by one of the ablest men connected with the surgical profession in the country.

'Immediately, as soon as the body is removed from the water, press the chest suddenly and forcibly downward and backward, and instantly discontinue the pressure. Repeat this without interruption, until a pair of common bellows can be procured; when obtained, introduce the nozle well upon the base of the tongue. Surround the mouth with a towel or handkerchief, and close it. Direct a bystander to press firmly upon the projecting part of the neck, (called Adam's apple,) and use the bellows actively.

How should the circulation be at first re-established? What should be avoided? What treatment should be adopted when warmth begins to be restored? What efforts should be made to recover suspended animation in drowned persons?

'Then press upon the chest to expel the air from the lungs, to imitate natural breathing. Continue this an hour, at least, unless signs of natural breathing come on. Wrap the body in warm blankets and place it near the fire, and do everything to preserve the natural warmth, as well as to impart artificial heat if possible. Every thing, however, is secondary to inflating the lungs. Send for medical aid immediately. Avoid all frictions until respiration shall be in some degree established.

'VALENTINE MOTT,
'*Surgeon General of American Shipwrecks Society.*

'May, 1844.'

As soon as the patient is able to swallow, a little cordial or warm brandy and water should be cautiously administered. The too common practice of rolling a person laboring under asphyxia from drowning, on a barrel, or in salt, or of suspending him by the feet, is not only useless, but inhuman, and should never be practised. Treat the asphyxiated person as above directed, and send immediately for a physician.

Always remember to place the patient in pure air, and admit the attendants only into the apartment.

ASPHYXIA FROM HANGING OR STRANGLING.

Persons asphyxiated from this cause should be treated as follows. The knot should be *untied* from the neck, if practicable, instead of being cut, as in the latter act much force is necessary.

If very cold, the body should be warmed, as directed in asphyxia from drowning. What is most to be relied on, is, artificial respiration, as directed in the section on drowning. Next, the patient should be bled from the foot, or jugular vein; therefore a surgeon should be obtained as soon as possible.

It is the vulgar impression, in many sections of the country, that the law will not allow the removal of the cord from the neck of a body found suspended, unless the coroner be present. It is, therefore, proper to say, that no such delay is necessary, and that no time should be lost in removing the body.

What is said of rolling them on a barrel, &c.? What caution is given? What treatment is directed in recovering persons asphyxiated from hanging? What erroneous impression prevails in the community?

ASPHYXIA FROM VAPOR OF CHARCOAL.

This generally results from ignorance. A person retires to bed, or shuts himself up in a room with a pan of ignited charcoal, which is placed there for the purpose of warming the air in the room. If not soon removed death is the consequence.

An individual laboring under partial or complete asphyxia from this cause, should be treated in the following manner. Remove the clothes from the body and place it in the *open air*, upon the back, with the head and shoulders a little elevated.

The face and chest should be sponged, or sprinkled with cold water, or cold vinegar and water. Apply friction, with a rough towel or flesh-brush, to the skin, and resort to artificial respiration, as directed in case of drowning. All these measures should be resorted to promptly, and, if necessary, continued for several hours.

COLDS.

The treatment of a simple cold or cough is not properly understood by the matrons in the community; although each may have their 'cure all' for it, or some excellent specific, usually it is treated in a manner that coincides with the popular adage, 'stuff a cold, and starve a fever.' The stuffing is generally accomplished, by taking large quantities of food and hot stimulating teas; most frequently, the latter is taken exclusively. It is true, that many have suffered and recovered, and the treatment on this account has been deemed the correct one. It is also true, that many recovered from fever and small pox, sixty years since, when no cold or fresh air was allowed these patients. But let a physician practise in this pernicious manner at the present time, and his reputation as a practitioner would be destroyed. Success is no proof of the correct management of colds thus treated, any more than it was in the fever and small pox, several years since. In the simple cold, as well as other diseases, it is essential to know its character, that the treatment may be safe and efficacious.

How is asphyxia or suspended animation produced by charcoal? What treatment is recommended?

A cold is generally induced by a chill, that produces a contraction of the blood-vessels of the skin; and the waste material which should be carried from the body, by the agency of the exhalent vessels of this membrane, is retained in the system, and a great portion of it is turned to the mucous membrane of the lungs; because it is a law of the animal economy that organs similar in their functions have sympathy with each other.

The waste material that should have passed through the many outlets of the skin, creates an unusual fullness of the minute vessels that nourish the muco-bronchial membrane; this induces an irritation of these vessels, which irritation increases the flow of blood to the nutrient arteries of the lungs. There is also a thickening of the lining membrane of the lungs, caused by the fullness of the muco-bronchial vessels; this impedes the passage of air through the small bronchial tubes, and consequently, the air vesicles cannot impart a sufficient quantity of oxygen to purify the blood. Blood imperfectly purified does not pass with facility through the lungs. An additional obstacle to the free passage of air into the lungs, is the accumulation of blood in the nutrient and pulmonary vessels.

Treatment —To effect a speedy cure, it is necessary to diminish the amount of fluid in the vessels of the lungs. This can be effected in two ways. 1st. By diminishing the quantity of blood in the system. 2d. By diverting it from the lungs to the skin. The first condition can be easily and safely effected, by abstaining from food, and drinking no more than a *gill* of fluid in twenty-four hours. The quantity of blood by this procedure will be diminished, and the lungs relieved of the accumulated fluid.

The second condition can be accomplished by resorting to the warm or vapor bath. These and the common sweats, will invite the blood to the skin from the lungs. By keeping up the action of the skin for a few hours, the lungs will be relieved. In some instances, emetics and cathartics are necessary. Mucilages, as gum arabic, or slippery-elm bark, would be good. After the system is relieved, the skin is more impressible to cold, and consequently requires careful protection by clothing.

What is the proper treatment of colds? Give the physiological reason?

MEANS OF TEMPORARILY ARRESTING THE FLOW OF BLOOD.

HEMORRHAGE.

If any large artery be severed, the blood will be thrown out in *jets* or *jerks*, and will be of a *bright red* color. The effusion may be so great as to endanger life.

Fig. 193.

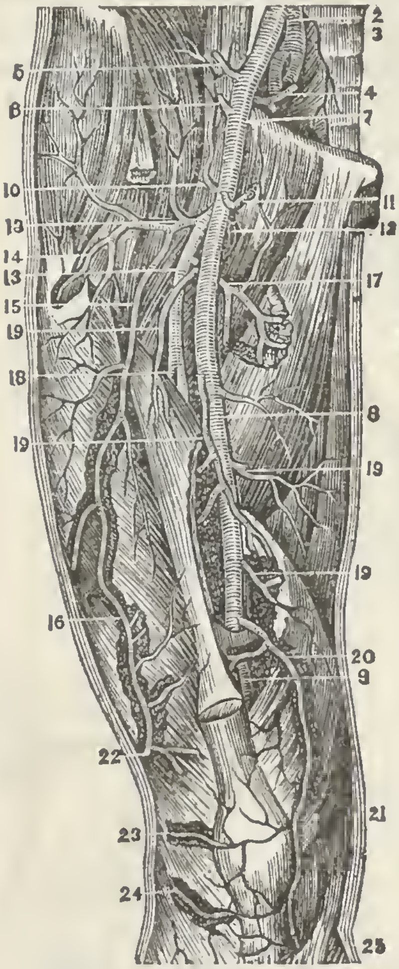

Fig. 194.

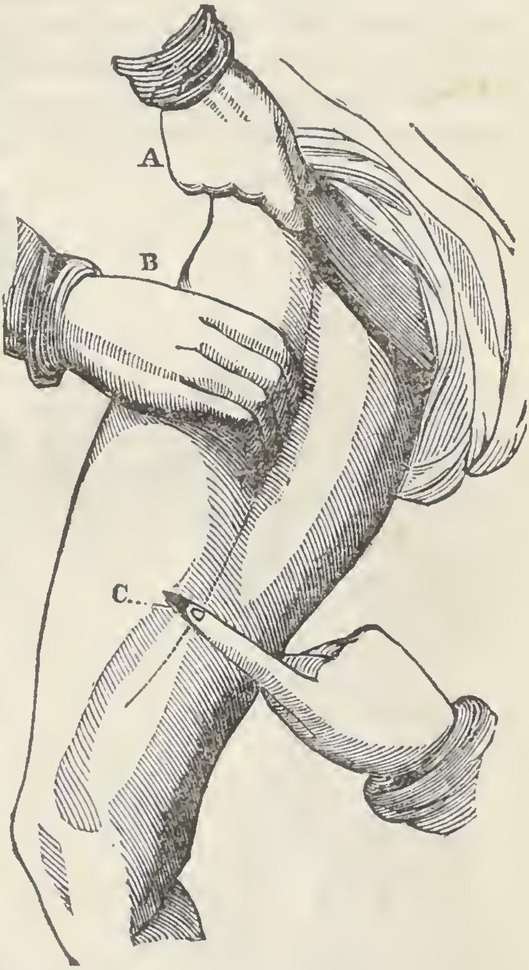

Fig. 193. The course of the femoral artery seen at 2, 7, and 8.

Fig. 194. A, method of compressing the femoral artery at the groin with the thumb or a compress. B, method of compressing the femoral artery below the groin with the fingers. C, method of compressing the mouth of the divided artery in the wound, with the fingers. The dotted line indicates the course of the artery.

When such accidents occur, the person wounded, or some individual who may be present, should arrest the bleeding, by making pressure upon the artery, between the heart and the point of its division, or by using compression directly upon the open mouth of the divided vessel.

How can hemorrhage be arrested?

The best instrument to use in compressing bleeding arteries, is the *finger.*

If a person receive a wound in the foot, leg, or thigh, and it bleed profusely, the hemorrhage should be arrested immediately, or life will be sacrificed. This may be done by making forcible compression with three or four fingers of one or both hands, on the upper and inner part of the thigh, over the course of the main femoral artery. Or make compression in the wound, upon the open mouth of the bleeding vessel. This is the most certain and best means of making pressure to arrest hemorrhage.

Fig. 195.

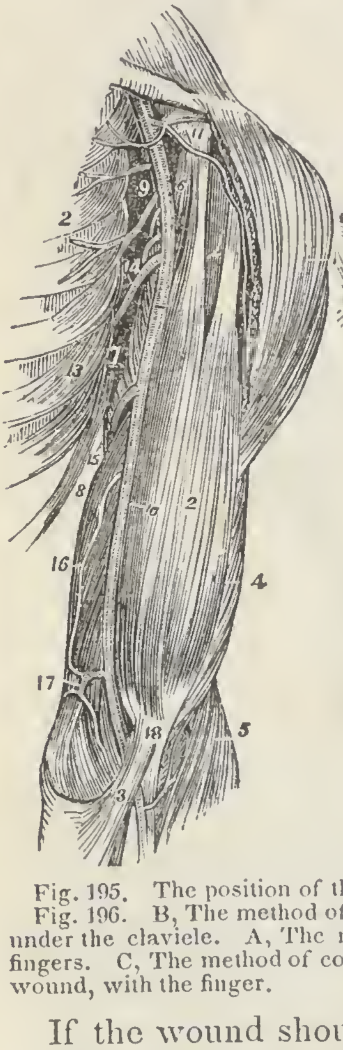

Fig. 196.

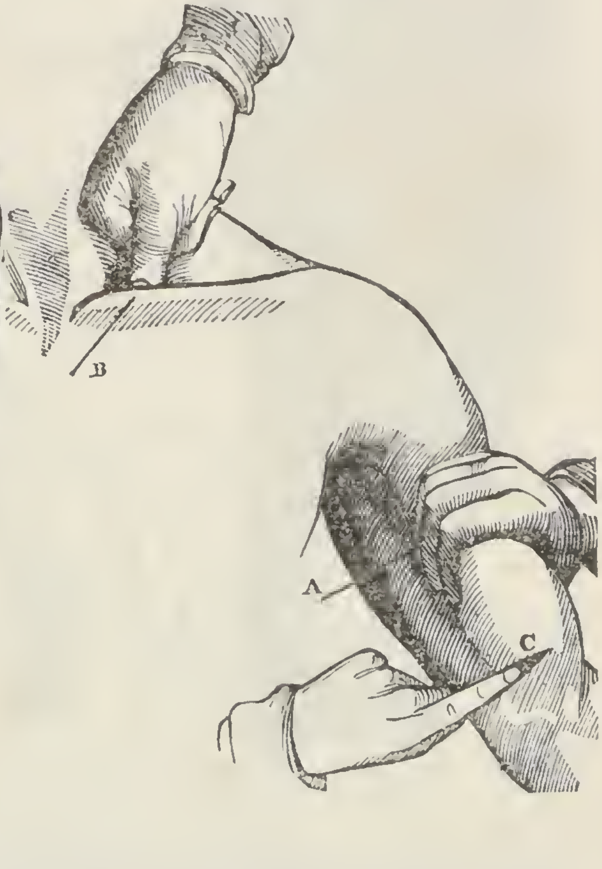

Fig. 195. The position of the axillary artery (9) and the brachial artery (10.)

Fig. 196. B, The method of compressing the subclavian artery upon the first rib under the clavicle. A, The method of compressing the brachial artery with the fingers. C, The method of compressing the divided extremity of an artery in the wound, with the finger.

If the wound should be in the upper part of the thigh,

What is the best compress? How is the compression effected? Another method?

then compression should be made on the artery where it passes over the bone at the groin. It can easily be found by its pulsation.

If the wound should occur in the hand, fore-arm, or arm, the brachial artery may be compressed with three or four fingers, or the subclavian may be compressed above and behind the clavicle, where it passes over the first rib, or, which is preferable, pressure may be made in the wound upon the mouth of the bleeding vessel.

Fig. 197.

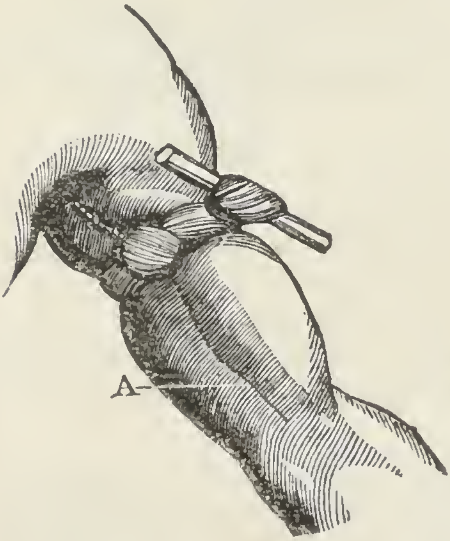

Fig. 198.

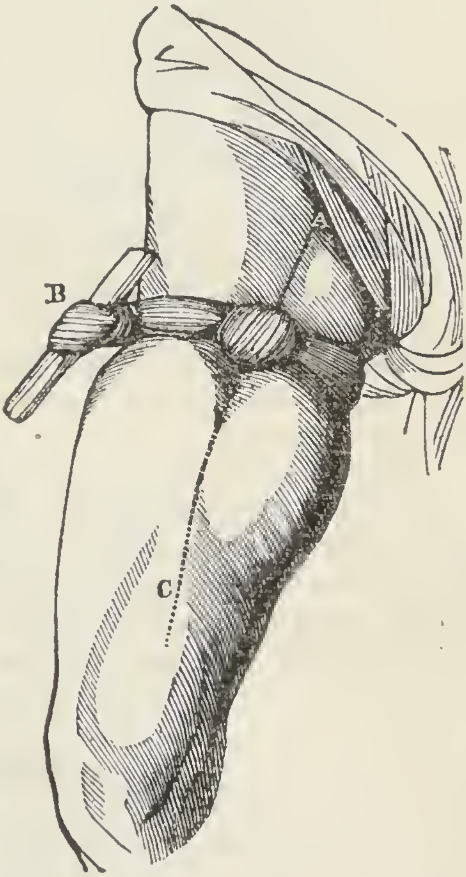

Fig. 197. The method of applying the knotted handkerchief on the track of the brachial artery, A.

Fig. 198. A, C, The track of the femoral artery. B, The method of applying the knotted handkerchief to make compression on the femoral artery.

After making compression, as before described and illustrated, you should request some person to twist a handkerchief corner-wise, and tie a hard knot midway

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Where should the compression be made if the wound is in the arm or hand?

between the two ends. This knot should then be placed over the artery, between the wound and the heart, and the two ends carried round the limb, and loosely but firmly tied. A stick five or six inches long should then be passed under the handkerchief, which should be twisted by it until the knot has made sufficient compression on the artery to allow the removal of the fingers, without a return of the hemorrhage. Continue this compression until the surgeon arrives, who will proceed to put ligatures around the divided and bleeding vessels, or pursue such a course as he may deem proper for the welfare of the patient.

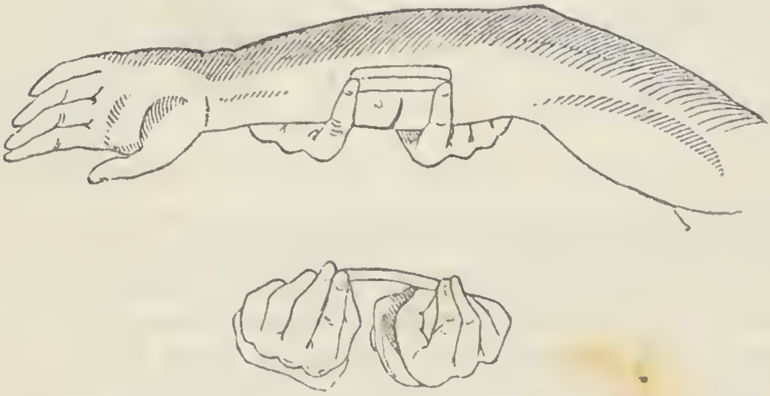
The wound ought not to be stuffed with pieces of cloth or lint, nor should any irritating application whatever be made to it.

TREATMENT OF SLIGHT WOUNDS.

If no large vessel, but many small ones are divided, there is usually no danger from excessive hemorrhage. In such instances, press the lips of the wound together for a few minutes; then wash it out with cold water. The bleeding is stayed by the divided vessels retracting into the flesh and by the contraction of the mouths of the severed arteries.

After the bleeding has ceased, cleanse the wound of coagulated blood and other foreign substances; then bring the divided parts together and retain them by narrow strips of adhesive or resinous plaster. These should be put on smoothly. Cover the strips of plaster with a thin fold of cloth, and put a bandage loosely around the part.

Fig. 199.

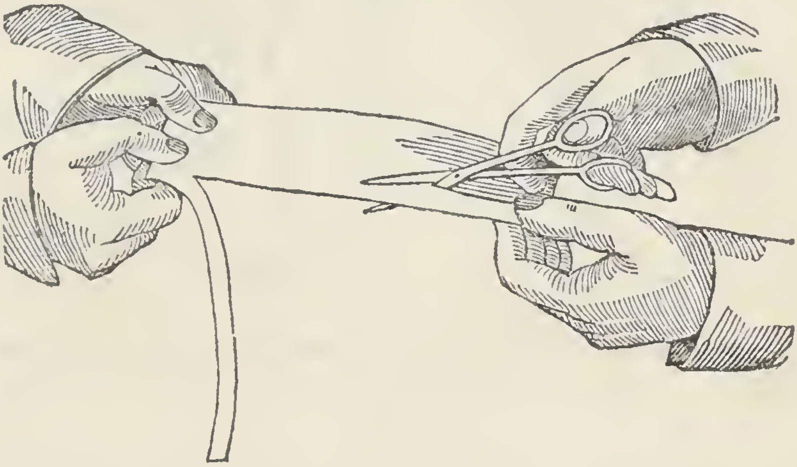


Mention a form for a continued compress. How long should this compression be continued? Should irritating applications be made to wounds? What is the treatment of slight wounds?

Fig. 199 represents the manner in which these strips of plaster are held and applied to the wound.

In most instances, in domestic practice, the strips of plaster used to dress wounds, are much too wide. In all instances, let the cloth be smoothly covered with the plaster. Cut it into narrow strips, not more than one fourth of an inch wide; apply a sufficient number of them to cover the wound. The following engraving represents the manner of cutting these strips.

Fig. 200.



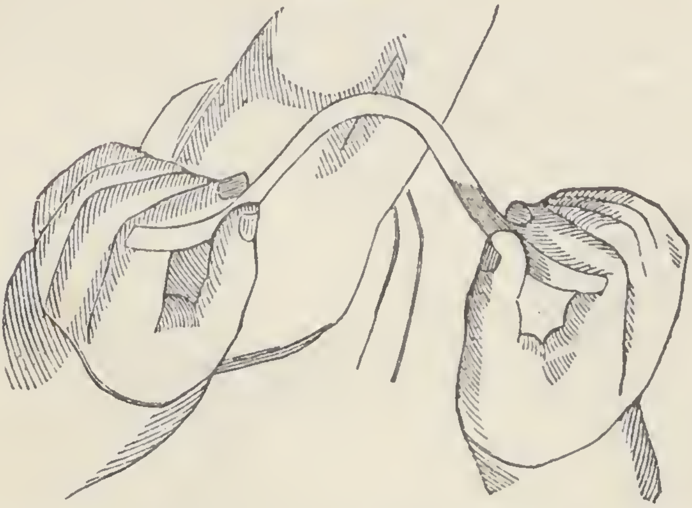
In a simple wound dressed in this way, the dressings need not be removed for *five* or *six* days; when they are removed, the parts may be cleansed by washing with weak soap suds, or warm water, and if needed, fresh strips of adhesive plaster may be applied. In removing the dressing from a wound, remember to raise each end of the strip of plaster and draw it toward the wound. This is important, as the liability of the wound re-opening is thus diminished. It will be well, perhaps, to say a word or two against the common practice of applying irritating substances, such as *balsams* and *healing salve*, in fresh cuts. They only aggravate the wound, cause more pain, and prevent its healing by what surgeons call the first intention, — that is, by the immediate union of its edges.

If a wound be ragged, dirty, or what is called a *lacerat-*

How broad should the adhesive strips be cut? What caution is given in removing dressing from a wound? What is the effect of applying balsams and healing salves?

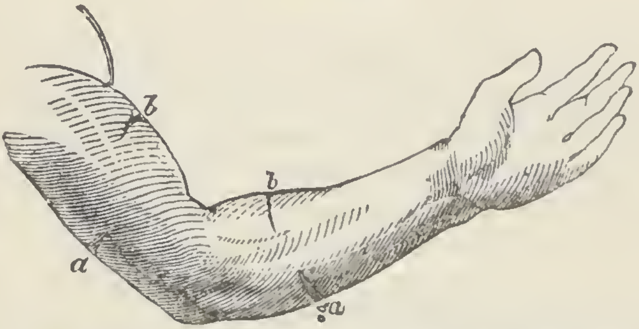
ed wound, apply cold water, and let it be seen by a surgeon as soon as possible. The following engraving represents the manner of removing the strips of adhesive plaster.

Fig. 201.



The proper position of the limbs favors the union of wounds.

Fig. 202.



In Fig. 202, wounds are represented at *a*, *a*, on the back part of the arm and forearm. Wounds are also represented at *b*, *b*, on the anterior part of the arm and forearm. The arm is represented as flexed at the elbow and at the wrist. By this bending of the wrist and elbow, the wounds at *a*, *a*, are opened, while the wounds at *b*, *b*, are closed. If the arm were extended at the elbow, and the hand at the wrist, the wounds *a*, *a*, would be closed, and those at *b*, *b*, would be opened.

If a wound be upon the anterior part of the thigh, by bending the thigh upon the body and extending the knee, the wound will be closed. If the wound be upon the back part of the thigh, by extending the thigh upon the

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What is the treatment of lacerated wounds? Describe how different parts of the system can be placed, to favor the union of wounds.

body, and flexing the knee, it will favor its closing. If the wound be upon the anterior part of the leg, between the knee and ankle, extending the knee and flexing the ankle, will aid its closing. If the wound be upon the back part of the leg, between the ankle and knee, by extending the foot and bending the knee, the gaping of the wound will be diminished. In wounds upon the anterior part of the trunk of the body, by keeping the body flexed, the wound will be lessened. In wounds upon the back part of the trunk, by keeping the body straight, the union of such wounds will be aided.

EXTRANEOUS BODIES IN THE EAR.

‘ Peas, beans, tamarind stones, and numerous other extraneous bodies, may be introduced into the ear by children, and if not extracted, cause much pain, swelling, and perhaps a formation of matter. If within sight, they may generally be extracted with a small pair of forceps or tweezers, or a double hair pin may be bent into a blunt hook at its bent end so as to form a kind of scoop, and passed behind the substance, which may in this way be extracted. A stream of warm water thrown in by means of a small syringe, may sometimes prove successful, and in its return wash out, if it be small, the substance which has been introduced.

Should the extraneous body be a bean, a pea, or any of the grains, water ought not to be used, as the moisture would cause it to swell, and it would afterward be found much more difficult to extract them.

When much difficulty is met with, the substance ought not to be picked at too long, nor ought an unprofessional person to endeavor for a long time to extract it, for by so doing, not only is inflammation more likely to be excited, but more difficulty will be experienced by the surgeon, in his after attempts to extract it; under such circumstances send for a surgeon without delay.

Worms and insects sometimes find their way into the ear, producing severe pain and causing much terror to the patient.

How can foreign bodies be removed from the external ear? Should water be thrown into the ear if the foreign body is any of the grains? Should attempts to remove such bodies be long continued? Why? How can worms and insects be dislodged from the ear?

These can usually be driven out by the introduction of a little warm olive or almond oil.'

EXTRANEOUS BODIES IN THE NOSTRILS.

Foreign bodies are sometimes introduced into the nostrils by children, causing irritation and sometimes inflammation, if allowed to remain. They should therefore be removed as soon as possible. This can be done by using the forceps, tweezers, or a blunt hook, as directed in the section on removing foreign bodies from the ear; or they may be pushed back into the throat. Care should be taken not to injure the bones nor the lining membrane of the nostrils. If the substance be not easily extracted, a surgeon should be obtained at once.

EXTRANEOUS BODIES IN THE THROAT.

'These accidents are very frequent, always alarming, and sometimes of fatal occurrence. It is an accident which requires immediate relief, or life may be lost. It is therefore very desirable that every one should know what to do in such a case.

It is not necessary to ascertain which passage the foreign body is in, when this accident takes place, for the immediate treatment ought to be the same. A bystander should place one hand flat on the front of the chest of the sufferer, and with the other give two or three smart blows upon the back, allowing a few seconds to intervene between them. This will generally be successful, and cause the substance to be violently ejected.

If the sufferer be a child it should be taken between the knees of the operater, who should be seated on a chair, and the same proceedings practised.

If not successful at once, a surgeon ought to be obtained as soon as possible, who, if in time, may save the life of the patient.'

EXTRANEOUS BODIES IN THE EYE.

Small particles or dust may become lodged in the eye and produce much inconvenience and irritation, which are

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How can foreign bodies be removed from the nose? What method should be pursued to remove a foreign body from the œsophagus or trachea? How should a person proceed if the sufferer is a child?

often increased by harsh attempts to remove them. The attempt to remove them should be made in the following way:

The person should be placed before a strong light, the lids held open with one hand or by an assistant, and the particles brushed away with the corner of a fine cambric or silk handkerchief. Sometimes the substance is concealed under the upper eyelid, and it may then be exposed by turning back the lid in the following manner.

Take a knitting needle or small slender piece of stick, which is perfectly smooth, and place it over the upper lid in contact with, and just under the edge of the orbit; then holding it firmly seize the lashes with the fingers of the disengaged hand and gently turn the lid back over the stick or needle.

You can then examine the inner side of the lid and remove any substance that may have been there concealed. Too many trials ought not to be made, if unsuccessful, as much inflammation may be induced by so doing; but a surgeon, in such cases, ought to be consulted as soon as possible.

Machinists, cutlers, and other artisans, are liable to have small, sharp pieces of steel or iron fly into the eye. These can usually be removed (if the person attempting it have a steady hand) with the point of a fine pen-knife or by a needle.

Eye-stones ought never to be placed in the eye, as they often cause more pain and irritation than the evil which they are intended to remedy.

MANAGEMENT OF FRACTURES AND DISLOCATIONS.

In cases of supposed fracture or dislocation of the lower extremity, the person should be carefully placed upon a bed or sofa, if he be at home, the parts placed in the most comfortable position, and a surgeon sent for at once.

If the injury be of the upper extremity, the part should

How can foreign bodies be wiped from the eye? What should be the position of the patient? How should the lids be held? How can the upper lid be turned up? How can small pieces of steel be removed from the eye? Should eye-stones be put into the eye? In fracture or dislocation of the lower extremity, how should the limb be placed? How in injury of the upper extremity?

be placed and supported in the most comfortable attitude.

The bystanders ought not to handle the affected part any more than is absolutely necessary to place it in the most comfortable position, and above all they ought to avoid making any attempt to set bones, as much injury may be caused by so doing.

Cloths wet with spirit and water, either cold or warm, as may be most agreeable to the patient, if there be no external wound, may be applied to the part; but if an external wound should be present, then water without spirits should be used. Such an accident may happen away from home, and even at a distance from any house. In such a case, a litter should be constructed as speedily as possible, the patient laid upon it, and conveyed to his home. If near a house, a litter can be easily constructed, by taking two boards sufficiently wide and long, and nailing them to two narrow cross-pieces, which will answer for handles. The boards may be covered with a folded blanket, or counterpane, or a narrow mattress may be placed upon them. A settee, upon which two or three pillows are placed, will answer the purpose very well.

CONCUSSION OF THE BRAIN.

In injuries of the brain, the symptoms are usually alarming, and all should possess some information for such contingencies. In general, such accidents are attended by insensibility; the skin and extremities are pale and cold, the pulse is very weak and feeble, and the circulation is much reduced in power; the respiration also is less deep, full, and complete, and is reduced in frequency.

Treatment.—In the first instance, the individual should be placed in pure air, and friction and dry warmth should be applied to the pallid and cold skin. This should be assiduously persevered in, until heat and color are restored to the skin and limbs, and due action of the heart and arteries has been established. Mild stimulants may also be used internally, with much advantage. The sympathizing

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Ought injured limbs to be much handled? Should the by-standers attempt to set them? With what should they be wet? How can a litter be constructed? Mention some of the effects arising from injuries of the brain. The treatment.

friends should not be permitted to stand about the patient, as they vitiate the air, as explained in the Sections upon the Lungs. There should be no bleeding until the skin and extremities become warm.

SICK-ROOMS.

The Management of the Sick-Room demands some attention. Ordinarily, in all acute diseases, the sick cannot take food, as the digestive organs are impaired in their functions; the air also, being more or less confined and vitiated, tends to render the blood impure. Should the disease be of the lungs, the effect upon the blood would be very much increased in consequence of the consolidation of the lung; under such circumstances, much watchful care is required on the part of the physician and nurse, to manage the food so that the disease may not be increased by the nutriment introduced, or the system prostrated by its being withheld. The food should be under the guidance of the *physician* in every case. When the person is recovering from illness, the food should be given with regularity, and in quantities not so great as to oppress the stomach, and not too frequently. (See chap. on Digestion.) The room should always be well ventilated.

When a person is sick, company should not be admitted, for the reason that the nervous system is highly impressible. This should be the governing rule in the room of the sick child, as well as the adult. Observation shows the contrary of this to be the common practice. Should we judge by the chattering, and news-telling, that are often heard in sick rooms, we might safely conclude that the sick child was destitute of ears, or that at least it had an insensible brain.

The attendant physician should direct when company may be admitted into the sick-room. No other individual knows so well as the physician the condition of the sick person. The duty devolves upon him, and not on the nurse, or friends, of excluding company when injury would arise from the admission. In the matter of visiting the sick as friends, there should be no *privileged class* known by the physician.

What is said of the management of sick rooms? In regard to food? Why should company not be admitted? What duty devolves upon the physician?

POISONS AND THEIR ANTIDOTES.

Poisoning, either from accident or design, is of such frequency and danger, that it is of the greatest importance that every person should know the proper mode of proceeding in such cases, in order to render immediate assistance, when within their power.

Poisons are divided into two classes. *Mineral* (which will include the acids) and *vegetable*.

The first thing to be done, when it is ascertained that a poison has been swallowed, is, to evacuate the stomach; unless vomiting takes place spontaneously. Emetics of the sulphate of Zinc (white vitriol) or Ipecacuanha, (Ipecac.) or the wine of antimony should be given.

When vomiting has commenced, it should be aided by large and frequent draughts of the following drinks: Flaxseed tea, gum water, slippery elm tea, barley water, sugar and water, or anything of a mucilaginous or diluent character.

MINERAL POISONS.

Ammonia.—The *water of ammonia*, if taken in an overdose and in an undiluted state, acts as a violent corrosive poison.

The best and most effectual antidote is *vinegar*. It should be administered in water without delay. It neutralizes the ammonia and renders it inactive. Emetics should not be used in these cases.

Antimony.—The *wine of antimony* and *tartar emetic*, if taken in over doses, cause distressing vomiting. In addition to the diluent mucilaginous drinks, give a tea-spoonful of the syrup of poppies, paregoric, or twenty drops of laudanum, every twenty minutes, until five or six doses have been taken, or the vomiting ceases.

The antidotes are *nut galls* and *oak bark*, which may be administered in infusion.

Arsenic.—When this has been taken, administer an emetic of ipecac. speedily, in mucilaginous teas, and use the stomach pump as soon as possible.

Into how many classes may poisons be divided? What is the antidote when *ammonia* is too freely taken? Should emetics be given? The antidotes for *antimony*? What should be the treatment when *arsenic* is taken?

The antidote is the *hydrated peroxide of iron.* It should be kept constantly on hand at the apothecaries' shops. It may be given in any quantity, without injurious results.

COPPER.—The most common cause of poisoning from this metal, is through the careless use of cooking utensils made of it, on which the *acetate of copper* (*verdigris*) has been allowed to form. When this has been taken, immediately induce vomiting, give mucilaginous drinks, or what is still better, the *white* of *eggs* diffused in water.

The antidote is the *carbonate* of *soda*, which should be administered without delay.

LEAD.—The *acetate* (*sugar*) *of lead* is the preparation of this metal, which is liable to be taken accidentally in poisonous doses. Induce immediate vomiting by emetics and diluent drink.

The antidote is diluted *sulphuric acid.* When this acid is not to be obtained, either the sulphate of magnesia (epsom salts) or the sulphate of soda (glauber's salt) will answer every purpose. They should be given in weak solution.

MERCURY —The preparation of this mineral, by which poisoning is commonly produced, is *corrosive sublimate.* The mode of treatment to be pursued when this poison has been swallowed, is as follows. The *whites of a dozen eggs* should be beaten in two quarts of cold water, and a tumbler full given every two minutes to induce vomiting. When the whites of eggs are not to be obtained, soap and water should be mixed with wheat flour and given in copious draughts, and the stomach pump introduced as soon as possible. Emetics or irritating substances ought not to be given.

NITRE.—(*Saltpetre.*) This in over doses produces violent poisonous symptoms. Vomiting should be immediately induced by large doses of mucilaginous diluent drinks; but emetics which irritate the stomach ought not to be given.

ZINC.—Poisoning is sometimes caused by the *sulphate of zinc* (white vitriol.) When this takes place, vomiting

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How is poisoning from copper generally produced? The remedy? The antidote? The remedy for the *acetate of lead*? What should be given when *corrosive sublimate* has been swallowed? What should not be given? The remedy when *saltpetre* is taken? When *zinc*?

should be induced and aided by large draughts of mucilaginous and diluent drinks. Use the stomach pump as soon as possible.

The antidote is the *carbonate* or *super-carbonate* of *soda.*

Nitric, (aqua fortis,) muriatic, (marine acid,) or sulphuric (oil of vitriol) acids may be taken by accident, and produce poisonous effects.

The antidote is *calcined magnesia,* which should be freely administered, to neutralize the acid, and induce vomiting. When magnesia cannot be obtained, the *carbonate* of *soda* or *potash* may be given. *Chalk,* powdered and given in solution, or strong *soap suds,* will answer a good purpose when the others are not at hand. It is of very great importance that something be given speedily, to neutralize the acid. One of the substances above named should be taken freely, in diluent and mucilaginous drinks, as gum water, milk, flaxseed or slippery elm tea. Emetics ought to be avoided.

Oxalic acid.—This acid resembles the sulphate of magnesia, (epsom salts,) which renders it liable to be taken by mistake, in poisonous doses. Many accidents have occurred from this circumstance. They can easily be distinguished by tasting a small quantity. The *epsom salts,* when applied to the tongue, have a very bitter taste, while the *oxalic acid* is intensely acid.

The antidote is *magnesia,* between which and the acid, a chemical action takes place, producing the oxalate of magnesia, which is inert. When magnesia is not at hand, *chalk, lime, carbonate* of *soda,* or *carbonate* of *potash,* (salæratus) will answer as a substitute.

Give the antidote in some of the mucilaginous drinks before named. No time ought to be lost, but the stomach pump should be introduced as soon as a surgeon can be obtained.

Ley.—The ley, obtained by the leaching of ashes, may be taken by a child accidentally. The antidote is vinegar, or oil of any kind. The vinegar neutralizes the alkali, by uniting with it, forming the acetate of potash. The oil unites with the alkali, and forms soap, which is

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The antidote? What will neutralize *nitric, muriatic* or *sulphuric* acids? What should be avoided? What does *oxalic* acid resemble? How can it be detected? The antidotes? How should they be taken? The antidote when *ley* is taken into the stomach?

less caustic than the ley. Give, at the same time, large draughts of mucilaginous drinks, as flaxseed tea, &c.

VEGETABLE POISONS.

The vegetable poisons are quite as numerous, and many of them equally as violent, as any in the mineral kingdom. We shall describe the most common, and which, therefore, are most liable to be taken.

OPIUM.—This is the article most frequently resorted to by those wishing to commit suicide, and as it is used as a common medicine, is easily obtained. From this cause also, mistakes are very liable to be made, and accidents to occur with it. Two of its preparations, *laudanum* and paregoric, are frequently mistaken for each other; the former being given when the latter is intended.

Morphia, in solution, or *morphine*, as it is more commonly called by the public, is a preparation of the drug under consideration, with which many cases of poisoning are produced. It is the active narcotic principle of the opium, and one grain is equal to six of this drug in its usual form.

When an over dose of opium or any of its preparations has been swallowed, the stomach should be evacuated as speedily as possible. To effect this, as much tartar emetic as can be held on a ten cent piece, or as much *Ipecacuanha* as can be held on a twenty-five cent piece, should be dissolved in a tumbler of warm water, and one half given at once, and the remainder in twenty minutes, if the first has not in the mean time operated. In the interval copious draughts of warm water or warm sugar and water should be drank. The use of the stomach pump, in these cases, is of the greatest importance, and should be resorted to without delay. After most of the poison has been evacuated from the stomach, a strong infusion of *coffee* ought to be given, or some one of the vegetable acids, such as *vinegar*, or *lemon juice*, should be administered.

The patient should be kept in motion, and salutary effects will often be produced by dashing a bucket of cold

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What is said of vegetable poisons? What vegetable poison is quite frequently taken? Some of the reasons, why taken more than others? What is *morphia*? How much stronger than gum opium? What is the remedy? May the stomach pump be advantageously used for this poison?

water on the head. *Artificial respiration*, as recommended in the section on asphyxia from drowning, ought to be established and kept up for some time. If the extremities are cold, apply warmth and friction to them. After the poison has been evacuated from the stomach, stimulants, as warm wine and water, or warm brandy and water, ought to be given, to keep up and sustain vital action.

STRAMMONIUM.—*Thorn apple.* This is one of the most active narcotic poisons, and when taken in over doses, has in numerous instances caused death.

The treatment of poisoning with this vegetable is similar to that recommended in poisoning from opium.

HYOSCIAMUS.—*Henbane.* This article, which is used as a medicine, if taken in improper doses, acts as a violent irritating and narcotic poison.

Treatment,—similar to that of poisoning from over doses of opium.

CONIUM — *Hemlock.* Hemlock, improperly called by many, *cicuta*, when taken in an over dose, acts as a narcotic poison. It was by this narcotic that the Athenians used to destroy the lives of individuals condemned to death by their laws. Socrates is said to have been put to death by this poison.

When swallowed in over doses, the treatment is similar to that of opium, strammonium and henbane, when overdoses are taken.

BELLADONNA—*deadly night-shade.* CAMPHOR. ACONITE—*monkshood wolfsbane.* BRYONY—*Bryonia.* DIGITALIS—*Foxglove.* DULCAMARA—*Bitter-sweet.* GAMBOGE. LOBELIA—*Indian tobacco.* SANGUINARIA—*Blood-root.* OIL OF SAVINE. SPIGELIA—*Pink-root.* TOBACCO. STRYCHNINE—*nux-vomica*—All of these, when taken in over-doses, are poisons of greater or less activity. The treatment of poisoning by the use of any of these articles is similar to that pursued in over-doses of opium.

What further directions are given for such cases? What is one of the most active narcotic poisons? The remedy when an overdose of strammonia is taken? What is the effect of henbane, when taken in improper doses? Name other vegetable poisons. The treatment when taken in too large quantities?

SIGNS OF REAL DEATH, AND MEANS OF DISTINGUISHING IT FROM SUSPENDED ANIMATION.

It is no uncommon occurrence that persons considered dead, have been restored to life at the moment when a post mortem examination was to have been made or even when they were already in the coffin or tomb. This mistake arises from the difficulty of distinguishing *real* from *apparent* death.

1st. One of the most certain signs of death, is the stiffness of the corpse. Sometimes, however, this sign manifests itself during life. This renders it necessary to observe the differences between the stiffness of death, and that which effects a person laboring under suspended animation, or disease.

When a limb is stiff from *tetanus*, or *convulsions*, its position is changed with difficulty, and when this has been done, it immediately returns to its former state. In the stiffness of death, the position of a limb is easily changed, and it remains where last placed.

In *fainting*, or asphyxia, from strangulation, or impure air, the rigidity takes place immediately, and the breast and abdomen retain their heat. The rigidity of a corpse does not take place until some time after death, and when we can no longer perceive any heat in the body.

The inflexibility noticed in suspended animation, is easily distinguished from the stiffness of death. Suppose a person to be in a state of suspended animation ten or fifteen minutes, when the limbs are inflexible. It is impossible that this stiffness can be the result of death, since the bodies of those who die of asphyxia, do not become stiff for several hours.*

A person in a frozen state will be rigid, when not dead, and capable of being restored. In this state the *skin*, *breast*, *abdomen*, and all the organs are as stiff as the muscles, which is not the case in the rigidity of a corpse, in which the muscles alone offer much resistance. When the position of a frozen member is changed, a slight noise is produced by the breaking of the icicles contained in the part moved. This noise is not heard in the coldness of death.

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* The more sudden the death, the slower the rigidity takes place.

2d. If an individual, be supposed to have been dead a long time, and become *cold* and *soft*, the interment ought not to be hastened. Before deciding that death has taken place, a muscle of the arm or thigh should be laid bare, and electrified by means of the galvanic battery. If no sign of contraction appear, life may be considered extinct; if contraction take place, the individual is not dead, and the means directed for restoring the action of the heart and lungs, in asphyxia from drowning, should be adopted.

3. The sign of death most certain, is *well-marked putrefaction; but it does not belong to the unprofessional, to decide whether or not putrefaction has commenced; the physician alone can establish the fact.* Persons have often been seen with purple blotches and some other signs of putrefaction, and emitting an offensive odor, who were restored after the lapse of some hours, by the aid of appropriate remedies. Under some circumstances those appearances take place from mortification of a limb. The appearances of the face and eyes are not to be relied on as criteria of death. The aspect that they generally present is sometimes wanting, and at other times they are seen forty-eight hours before death.

4. The possibility of feeling the beating of the heart and the pulsation of the arteries, is no certain indication of death, as it is fully proved that a person may live many hours, without these pulsations being perceived.

5. An individual has been considered dead *when he ceases to breathe*; but experience proves that life may not be extinct, although no manifestation of the continuance of respiration can be perceived, by applying the flame of a candle to the nostrils, or a mirror before the mouth.

6. It has been thought that a person is dead when he is cold, and that he is alive if he preserves his warmth. This is of the least value of all the signs; for drowned persons, who can be restored to life, are ordinarily very cold; whilst those suffocated, etc., preserve their heat even a long time after death.

7. The sensibility of a patient may be destroyed in some diseases, so that incisions and blisters will not be felt by one who may ultimately recover, so that the absence of sensibility is no certain indication of death.

The result of the preceding explanations show, First, That no one of the signs enumerated, taken by itself, (except well-marked putrefaction,) is sufficient for pronouncing a person's life extinct. Secondly, That death ought to be regarded as real, in an individual who combines all these signs.

GLOSSARY.

Abdomen. From the Latin, *abdere*, to hide. The belly.

Absorption. From the Latin, *absorbere.* To suck up.

Acetabulum. From the Latin, *acetum*, vinegar. The socket for the head of the thigh bone.

Acromion. From the Greek, *akros*, extreme, and *ômos*, the shoulder.

Adeps. Fat, an oily matter contained in the cellular tissue.

Albuginea tunica. A membrane thus named from its whiteness.

Albumen. An animal substance, of the same nature as the white of an egg.

Aliment. From *alere*, to nourish.

Alveolus. From *Alveus.* The hole in which a tooth is placed.

Alveoli. Plural of alveolus. Sockets of the teeth.

Anastomosis. The communication of vessels with one another.

Antagonist. An epithet applied to a muscle acting against another.

Aorta. From the Greek, *aorte*, a vessel. The great artery which arises from the left ventricle of the heart.

Aponeuroses. From the Greek, *apo*, from, and *neuron*, a nerve. Membranous expansions of muscles and tendons are so called.

Apophysis. From the Greek, *apo*, from, and *phuô*, I rise. An eminence or process of bone.

Apparatus. Latin, *ad*, for, and *parare*, to prepare. An assemblage of organs.

Arachnoid. From the Greek, *arakne*, a spider's web, and *eidos*, resemblance.

Artery. From the Greek, *ær*, air, and *terein*, to preserve, because it was anciently believed that the arteries were filled with air. The vessels which convey blood *from* the heart to all parts of the body.

Articulate. From the Latin, *articulus*, a joint. To form a joint.

Articulation. A joint, a limb, derived from the Greek *arthron*, a joint.

Atlas. The first of the cervical vertebræ, so named from supporting the head, as Atlas was supposed to support the world.

Atmosphere. From the Greek, *atmos*, vapor, and *sphaira*, a sphere, or globe. The air which surrounds the earth.

Asphyxia. From the Greek *a*, without, and *sphuxis*, pulse. Suspended animation. Now used for suspended respiration.

Auditorius. Latin. Belonging or relating to the sense of hearing.

Auricle. From the Latin, *auris*, an ear. The two auricles of the heart derive their name from their resemblance to ears.

Axilla. Latin. The arm pit.

Axillary. Belonging or relating to the arm pit.

Azagos. A term applied to any part not having a corresponding part.

Bile. A yellow, viscid fluid, secreted by the liver.

Biceps. From *bis*, two, and *caput*, head. Composed of two heads.

Brachial. Belonging or relating to the arm.

Bronchi. From the Greek, *brogchos*, the throat. The ramifications of the trachea.

Cœcum. Blind. The term applied to the blind extremity of the colon.

Calcis. Latin. The heel.

Canine. From the Latin, *canis*, a dog. The name of certain teeth.

Capillary. From the Latin, *capillus*, a hair. Hair-like, small.

Capsule A membranous production inclosing a part like a bag.

Cardia. From the Greek, *kardia*, the heart. The left opening of the stomach, where the œsophagus enters it.

Carotid. The great arteries of the neck, which convey blood to the head.

Carpus. From the Greek, *karpos*, the wrist. The part between the fore-arm and hand.

Cartilage. Gristle, a matter softer than bone, but harder than ligament.

Cerebellum. The diminutive of *cerebrum*. The little brain. The inferior portion of the brain contained in the cranium.

Cerebro-spinal. Belonging or relating to both the cerebrum and spine.

Cerebrum. The brain. The term is sometimes applied to the whole contents of the cranium; at others to the upper portion.

Cervical. From the Latin, *cervix.* Belonging to the neck.

Cerumen. From the Latin, *cera*, wax. A secretion within the ear.

Choroid. From the Greek, *chorion*, (the skin,) and *cidos*, resemblance. The name of several vascular membranes.

Choledochus ductus. The common bile duct.

Chronic. From the Greek, *chronos*, time. A protracted disease.

Chyle. From the Greek, *chulos*, nutritious juice. A nutritive fluid, of a whitish appearance, which is extracted from food by the action of the digestive organs.

Chylification. From the Latin, *chylus*, chyle, and *facere*, to make. The formation of chyle by the digestive processes.

Chyme. From the Greek, *chumos*, juice. A kind of grayish pulp, formed from the food after it has been for some time in the stomach.

Chymification. From the Greek, *chumos*, juice, and the Latin, *facere*, to make. The formation of chyme.

Cilia. Latin. The eye-lashes.

Clavicle. From the Latin, *clavis*, a key.

Cochlea. Latin. A snail shell. The name of one of the three cavities which form the labyrinth of the ear.

Colon. The first portion of the large intestine.

Condyle. From the Greek, *kondulos*, a knot, an eminence, a bump. A small round eminence of bone entering into the composition of an articulation.

Conjunctiva. Latin. Formed from *con*, with, and *jungere*, to join. The mucous membrane which covers the anterior surface of the ball of the eye, and unites it to the lids.

Corion. The skin.

Cornea. From the Latin, *cornu*, a horn. One of the coats of the eye.

Costa. From the Latin, *custodio*, to guard. The ribs, because they guard the heart, &c.

Corpus callosum. From *corpus*, a body, and *callus*, hard.

Cranium. From the Greek, *kranon*, head. The skull.

Cribriform. From the Latin, *cribrum*, a sieve. Perforated like a sieve.

Cricoid. Greek. A ring. The annular cartilage of the larynx.

Crura. From the Latin, *crus*, a leg. Applied to parts resembling a leg.

Cuneiform. From the Latin, *cuneus*, a wedge. Wedge shaped.

Deglutition. From the Latin, *deglutire*, to swallow. The act by which substances are passed from the mouth into the stomach, through the pharynx and œsophagus.

Diaphragm. From the Greek, *diaphragma*, a partition. The fleshy or muscular partition between the cavity of the chest, and the cavity of the abdomen.

Diastole. From the Greek, *diastellô*, I open, I dilate. The dilatation of the heart and arteries when the blood enters their cavities.

Dissect From the Latin, *dis*, asunder, and *seco*, to cut. To cut asunder.

Dorsal. From the Latin, *dorsum*, the back. Belonging or relating to the back.

Duodenum. From the Latin, *duodecem*, twelve fingers' length. The first portion of the small intestine, so called from its general length.

Dura Mater. From the Latin, *durus*, hard, and *mater*, mother. The outermost membrane of the brain.

Epigastric. The superior part of the abdomen.

Epiglottis. From the Greek, *epi*, upon, and *glóttis*, the glottis. A species of cartilaginous valve, situated at the upper part of the larynx, behind the base of the tongue.

Ethmoid. From the Greek, *ethmos*, a sieve, and *eidos*, resemblance.

Excretion. From the Latin, *excernere*, to separate. The matter thrown off from the body, as useless, is termed excretion.

Excretory. An *excretory vessel*, or *duct*, is one which transmits the fluid secreted by a gland. *Excretory organ* means any organ charged with the office of excreting; thus, the skin is said to be an excretory organ. because through it the perspiration or sweat is *excreted*.

Exhalation. From the Latin, *exhalare*, to throw out, to exhale. The sweat is an example of an exhalation as well as of a secretion.

Extensor Latin. A muscle whose office it is to extend certain parts.

Extremities. The legs and arms.

Falciform. From the Latin, *falx*, a sythe. Shaped like a sythe.

Fascia. From the Latin, *fascis*, a bundle. The aponeurotic expansions of muscles, which bind parts together. are so termed.

Fasciæ. Plural of fascia.

Fasciculus. Diminutive of *fascis*. A little bundle.

Fauces The plural of the Latin, *faux*. The top of the throat.

Femur. Latin. The thigh bone.

Femoral. Relating to the femur.

Fenestra. Latin. A window, — an opening or hole.

Fibre. An organic filament, of a solid consistence. and more or less extensible. Fibres enter into the composition of every animal and vegetable texture.

Fibril. Fibrilla. A very small fibre.

Fibula. Latin. A clasp. The smaller bone of the leg.

Filament. From the Latin, *filamentum*, which is the diminutive of *filum*, a thread. A very small fibre, — a fibril.

Fissure. From the Latin, *fissura*. A long narrow cleft or opening.

Flex. To bend.

Flexion. The state of being bent.

Flexor. Latin. A muscle whose office it is to bend certain parts.

Follicle. From the Latin, *follis*, a bag. A diminutive, glandular sac, or bag

Foramen. Latin. A hole.

Foramina. The plural of foramen.

Fossa. From the Latin, *fodio*, I dig. A cavity of greater or less depth, the entrance to which is always larger than the base. The nostrils are called the nasal fossæ

Frænum. Latin. A bridle. The membranous ligament under the tongue.

Function. From the Latin, *fungor*, I act, I perform. The action of an organ or a set of organs.

Ganglion. From the Greek, *gagglion*, a knot. Nervous ganglions are enlargements or knots in the course of a nerve.

Ganglionic. Consisting of ganglions. Relating to ganglions.

Gastric. From the Greek, *gaster*, the stomach. Belonging or relating to the stomach.

Gelatine. From the Latin, *gelu*, jelly.

Glenoid. From the Greek, *glene*, the pupil, and *eidos*, resemblance. Any shallow, articular cavity, which receives the head of a bone.

Glottis. A small oblong aperture, situated at the upper part of the larynx.

Hemisphere. From the Greek, *hemisus*, half, and *sphaira*, sphere. The brain is divided into two hemispheres.

Hemorrhage. Greek. A discharge of blood from any vessel.

Hepatic. Applied to parts belonging to the liver.

Hyaloid. The capsule of the vitreous humor of the eye.

Hypogastric. The lower region of the fore part of the abdomen.

Iliac. From the Latin, *ilia*, the flank.

Ileum. To twist. A portion of the small intestines. so called from being found convoluted.

Ilium. The haunch bone.

Incisor. From the Latin, *incido*, I cut. The teeth which occupy the anterior part of the upper and lower jaws. are called incisors, or incisor teeth.

Incus. Latin. An anvil. A small bone of the internal ear.

Inferior. The lower of two parts.

Innominatum. Latin. Parts which have no proper name.

Intercostal. From the Latin, *inter*, between, and *costa*, a rib. Situated between the ribs.

Interosseous. From the Latin, *inter*, between, and *os*, bone. A term applied to parts situated between bones.

Iris. The membrane around the pupil of the eye, deriving its name from its various hues.

Ischium. To support. That part of the innominatum on which we sit.

Jejunum. From the Latin, *jejunus*, empty. A portion of the small intestines generally found empty.

Jugular. From the Latin, *jugulum*, the throat. The large veins of the neck.

Labyrinth. From the Latin, *labyrinthus*, a place full of turnings. Anatomists have given this name to the aggregate of parts constituting the internal ear.

Lachrymal. From the Latin, *lacryma*, a tear. Belonging to tears.

Lacteal. From the Latin, *lac*, milk. The name of vessels of the intestines which carry the chyle.

Lamina. Latin. A plate or thin piece of metal or bone.

Laminæ. Plural of lamina.

Larynx. From the Greek, *larugx*, a whistle. The apparatus of the voice, situated at the anterior and upper part of the neck.

Levator. From the Latin, *levare*, to lift. A muscle whose office it is to raise or elevate certain parts.

Ligament. From the Latin, *ligare*, to tie. A name given to fibrous structures, which serve to unite bones and form articulations.

Lobe. A round, projecting part of an organ.

Lumbar. Relating to the loins.

Lymph. A name given to the fluid contained in the lymphatic vessels and thoracic duct of an animal.

Mastoid. Shaped like a nipple or breast.

Maxilla. The jaw.

Meatus. Latin. A passage.

Medulla. Latin. Marrow.

Medulla Spinalis. The spinal cord.

Membrana. Latin. A membrane.

Membrane. From *membrana*, a film. A delicate web.

Mesentery. From the Greek, *mesos*, in the middle, and *enteron*, an intestine. The membrane in the middle of the intestines, by which they are attached to the spine.

Mesenteric. Relating to the mesentery.

Metacarpus. From the Greek, *meta*, after, and *karpos*, the wrist. That part of the hand which is between the wrist and fingers.

Metatarsus. From the Greek, *meta*, after, and *tarsos*, the instep. That part of the foot which is situated between the instep and toes.

Mitral. From the Latin, *mitra*, mitre. The name of two valves of the heart.

Molar. From the Greek, *mulos*, a millstone, or the Latin, *molo*, I grind. *Molar teeth*, the grinders.

Motor. That which moves or gives the power to move.

Mucus. A transparent, saline, glutinous fluid.

Nares. Latin. The nostrils.

Nasal. Relating to the nostrils.

Naviculare. From the Latin, *navicula*, a small boat. A bone of the tarsus, and also of the carpus.

Neurilæma. The sheath of a nerve.

Nutrition. The function by which the various organs receive the nutritious substances, necessary to repair their losses and maintain strength.

Oblongata. Latin. Lengthened.

Œsophagus. From the Greek, *oiô*, I carry, and *phagô*, I eat. The gullet, a tube leading from the mouth to the stomach for the transmission of food.

Olfactory. From the Latin, *olfactus*, the smell. That which belongs or relates to the sense of smell.

Omentum. From the Latin, *omen*, a prognostic. The caul, so called because the ancient priests prophesied from an inspection of this viscus.

Organ. From the Greek, *organon*, an instrument. Part of an organized being destined to exercise some particular function : as, the ears are organs of hearing.

Os. Latin. Bone.

Ossify. From the Latin, *os*, bone, and *fio*, to become. To change to bone.

Ossification. From the Latin, *os*, a bone, and *facere*, to make. The formation of bone.

Pancreas. From the Greek, *pan*, all, and *kreas*, flesh, that is, quite fleshy. A gland of the abdomen.

Pancreatic. Relating to the pancreas.

Parietes. From the Latin, *paries*, a wall. A name given to parts which form an enclosure.

Parotid. From the Greek, *para*, about, and *ous*, ear. The largest salivary gland.

Parenchyma. A substance, connecting vessels of the lungs, liver, &c.

Patella. From the Latin, *patina*, a dish. The knee pan.

Pericardium. From the Greek, *peri*, around, and *kardia*, the heart. The pericardium is a membranous sac, which envelopes the heart.

Periosteum. From *peri*, around, and *os*, bone. The membrane surrounding the bones.

Peritoneum. From the Greek, *peri*, around, and *teinô*, I stretch. A serous membrane which lines the abdomen, and covers entirely or in part all the organs in it.

Petrous. From the Greek, *petra*, a rock, or stone. A part of the temporal bone which contains the organs of hearing.

Phalanx. From the Greek, *phalagx*, a file of soldiers. The bones composing the fingers and toes are named phalanges from their regularity.

Pharynx. From the Greek, *pharugx*. the pharynx. The swallow, the superior opening of the œsophagus.

Phenomenon. From the Greek, *phainomai*. I suppose. Visible quality.

Pituitary. Producing phlegm. A term applied to the membrane of the nose.

Phrenic. From *phren*, the mind. The ancients supposed the diaphragm to be the seat of the mind. A name given to a nerve.

Psoas. From the Greek. The loins.

Post Mortem. Latin. After death.

Popliteus. From the Latin, *poples*, the ham. A muscle of the leg.

Process. From the Latin, *procedo*, I go before. An eminence of bone — an apophysis.

Pulmonary. From the Latin, *pulmo*, the lungs. Relating to the lungs.

Pylorus. From the Greek, *pule*, a gate, and *ouros*, a guardian. The lower and right orifice of the stomach.

Radius. Latin. A spoke. The small bone of the fore arm.

Ramus. A branch.

Region. From the Latin, *rego*, I rule. Parts of the body.

Retina. From the Latin, *rete*, a net. The essential organ of vision.

Rotator. From the Latin, *rota*, a wheel. A name given to muscles which turn the parts to which they are attached on their axes.

Rotundum, Rotunda. Latin. Round.

Sacrum. The bone which forms the posterior parts of the pelvis, and is a continuation of the vertebral column.

Saliva. The fluid secreted in the mouth.

Sartorius. From the Latin, *sartor*, a tailor. The muscle which is called into action when a tailor crosses his legs.

Sclerotic. From the Greek, *skleroô*, I harden. A membrane of the eye.

Secretion. From the Latin, *secernere*, to separate. The organic functions of the several glands, by which they separate from the blood the material which they respectively demand for their several purposes.

Serum. One of the constituents of blood.

Serous. Thin, watery.

Sigmoid. Resembling the Greek ς, sigma.

Skeleton. From the Greek, *skellô*, I dry. The aggregate of the hard parts of the body. The bones.

Sphenoid. From the Greek, *sphen*, a wedge, and *eidos*, resemblance. A bone of the skull.

Sphincter. To contract. The name of several muscles, the office of which is to close the apertures around which they are placed.

Stapes. Latin. A stirrup. A bone of the internal ear.

Spine. From the Latin, *spina*, a thorn. The back bone. A prominence upon a bone.

Sternum. From the Greek, *sterros*, solid. The breast bone.

Sub. Latin. Under.

Sublingual. From the Latin, *sub*, under, and *lingua*, the tongue.

Superior. The upper of two parts.

System. From the Greek, *sun*, together, and *istemi*, I place. An arrangement according to some plan or method.

Styloid. A process like a pencil on the temporal and other bones.

Systole. From the Greek, *sustellô*, I contract. The contraction of the heart, by which it gives impulse to the blood in the arteries. It is opposed to the diastole of this organ.

Tarsus. From the Greek, *tarsos*, any row, the soles of the feet. The posterior part of the foot, which in man consists of seven bones, and forms the heel and instep.

Tegument. From the Latin, *tego*, to cover. Any membrane.

Tendon. From the Greek, *teinô*, I stretch. Strong, white, fibrous cords, which connect the muscles to the bones which they move.

Thorax. From the Greek, *thôrax*, the chest, or that part of the body which contains the lungs and heart.

Tibia. Latin. A flute. The largest bone of the leg.

Thoracic. Belonging to the thorax.

Thyroid. Greek. A shield. A cartilage of the larynx. Vulgarly called Adam's apple.

Tissue. From the Latin, *texere*, to weave. It is applied to the different kinds of organization of the body; as, for example, the *muscular* tissue, *osseus* tissue, meaning the structure of which the muscles and bones are composed.

Trachea. From the Greek, *trachus*, rough. The canal which conveys air to the lungs The windpipe.

Tunica. Latin. A tunic, a coat or covering of an organ.

Tympanum. Latin. A drum. The middle ear.

Valve. From the Latin, *valvæ*, a door. Any membrane or doubling of any membrane which prevents fluids from flowing back in the vessels and canals of the animal body.

Vascular. From the Latin, *vas*, a vessel, consisting of little vessels.

Veins. From the Latin, *vena.* The vessels that convey blood *to* the heart.

Venous. Relating to veins.

Ventricle. From the Latin, *venter*, a belly. In anatomy, a name given to various parts.

Vermicular. From the Latin, *vermis*, a worm. Motion like the movement of a worm.

Vertebra. From the Latin, *vertere*, to turn. This name has been given to each of the bones, which by their union form the vertebral or spinal column.

Vertebræ The plural of vertebra.

Vesicle. From the Latin, *vesica*, a bladder. A bladder-like cavity.

Viscid, Viscous. Glutinous, sticky, tenacious.

Viscus. Latin. Any bowel or entrail, or internal part, as the heart, liver, and lungs.

Viscera. The plural of *viscus.*